CHILDHOOD IMMUNIZATIONS IN FOUR DISTRICTS IN RURAL PAKISTAN: A COMPARISON OF IMMUNIZATION UPTAKE ACROSS STUDY YEARS (1994 AND 1997) AND AN ANALYSIS OF CORRELATES

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ABSTRACT

Immunization has been used as an upstream, protective measure in public health for decades. Although immunization programs have been introduced in Pakistan, new and emerging infectious disease remains a concern in the country. The province of Sindh, Pakistan is of special concern because of its large rural population.

The purpose of this study was to: 1) determine and compare complete and age-appropriate immunization uptake in children 12 to 36 months and birth to 9 months, respectively living in Sindh, Pakistan in 1994 and 1997; and 2) determine the correlates of complete and age-appropriate immunization in children 12 to 36 months and birth to 9 months, respectively living in Sindh, Pakistan in 1997.

This study reviewed data that was collected as part of the School Nutrition Program (SNP) and Family Health Project (FHP) in 1994 and 1997, respectively. Analyses included immunization data on 1877 children from the SNP survey and 1694 children from the FHP survey.

Females were found to have higher statistically significantly age-appropriate uptake than males in 1997 ($p=0.015$). Complete immunization status was also found to vary significantly by district of residence in 1994 and 1997 ($p<0.001$). Both complete and age-appropriate immunization status was found to decrease from 1994 to 1997.

Multivariable logistic regression revealed that not owning a radio, electricity, or bicycle was indicative of lower odds of complete immunization uptake ($OR<1$, $p<0.05$). Other correlates predictive of lower odds of complete immunization included owning a water pump (OR=0.360), not having a Lady Health Worker (LHW) visit the home (OR=0.489), living in a kucha house (OR=0.637), and living in Tharparkar (OR=0.290), Badin (OR=0.599), or Mirpur Khas (OR=0.271).

A similar regression analysis revealed child's sex, ownership of a refrigerator, and having heard of contraception to be correlates of age-appropriate immunization ($p<0.05$). Females had higher odds of age-appropriate immunization (OR=1.851) compared to males. Not having a refrigerator was indicative of lower odds (OR=0.079). Not having heard of at least one type of contraception was a predictor age-appropriate immunization (OR=1.925).

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LIST OF ABBREVIATIONS

AOR Adjusted Odds Ratio

BCG Bacillus of Calmette and Guerin vaccine

CNS Central Nervous System

DPT Diphtheria, Pertussis, Tetanus vaccine

EPI Expanded Programme on Immunization

FHP Family Health Project

HBM Health Behaviour Model

LDC Less Developed Countries

LQAS Lot Quality Assessment Sampling

MCV Measles Containing Vaccine

MMR Measles Mumps Rubella

NID National Immunization Days

NIS National Immunization Survey

OPV Oral Polio Vaccine

OR Odds Ratio

PPS Proportion to Population Size

SES Socioeconomic Status

SNP School Nutrition Program

UNICEF United Nations International Children's Emergency Fund

UOR Unadjusted Odds Ratio

WHO World Health Organization

CHAPTER 1

INTRODUCTION

Immunization is the act of being exposed to an immunogen for the purpose of fortifying the immune system against that immunogen. Immunization makes use of a killed form of the virus that is unable to cause disease. *Vaccination*, a similar process, involves the administration of a live, weakened virus, which can therefore potentially result in the development of the disease. For decades, immunization and vaccination have been used as an upstream, protective measure for protecting children, adolescents, adults and the elderly against such infections and infectious diseases as polio, tuberculosis, diphtheria, pertussis, tetanus, and the measles. Recent years have shown an increased interest in such preventative measures; efforts are being made to reduce the overall incidence and prevalence of these diseases worldwide.

1.1 The Pakistani Context

Pakistan is located in South-Asia and is home to roughly 155 million people (1). Bordering on Iran, Afghanistan, China, India, and the Arabian Sea, its landmass is approximately double the size of Canada's Newfoundland and Labrador.

With little available potable water, recent natural disasters, and health indicators already

mirroring those of other less-developed-countries (LDCs) (Appendix A), the fear of new and emerging infectious disease in the country is great. The concern grows deeper when examining the health of the country's 60 million children (<15 years) (1). Protecting and maintaining the health of these children is of utmost importance.

Within Pakistan, the province of Sindh is of special concern to researchers because it is home to roughly 30 million people with 61% living in rural areas (2). As a result, delivery and administration of immunizations is often difficult.

One of the four provinces of Pakistan, Sindh is both hot and humid. Within Sindh, the districts of Thatta, Badin, and Mirpur Khas are arid. With no rivers or natural water sources, potable water is in short supply. Residents of these districts often work in the industry and service sectors. Although there is minimal rainfall, an extensive irrigation system allows for agricultural production. The district of Tharparkar is also arid, but differs from the other districts in terms of religion. Located in the south of Sindh, the major religious group in Tharparkar is Hinduism. The absence of potable water in these areas is often associated with poor nutrition and difficulty in treating disease.

One way of relieving the burden of disease is through national immunization programs. The World Health Organization (WHO), which has helped in the planning and delivery of such programs, maintains that "immunization is essential for children to achieve their right to the highest attainable standard of health" (3). Tuberculosis, polio, measles, diphtheria, tetanus, and pertussis are all currently listed on the recommended childhood

immunization schedule for children in Pakistan (see Figure 1.1, below).

Figure 1.1 Pakistan's Childhood Immunization Schedule

	Age (months)				
Vaccine	*Birth*	*2*	*3*	*4*	*9*
BCG	Dose 1				
Diphtheria,		Dose 1	Dose 2	Dose 3	
tetanus,					
pertussis					
MCV					Dose 1
OPV	Dose 1	Dose 2	Dose 3	Dose 4	

*Immunization for Pakistan adapted from the World Health Organization (WHO) (1).

BCG = Bacillus of Calmette and Guerin MVC = Measles Containing Vaccine

DPT = Diphtheria Pertussis Tetanus OPV = Oral Polio Vaccine

1.2 Problem Statement

Historically, rural Pakistan has not been a major focus for researchers. The highly populous rural communities are not easily accessed and services to these areas are not immediately available. Research in Pakistan is therefore more often conducted in its urban centres. These studies tend to use clinical-based data. There has been a resulting need for population-based studies, especially in the rural districts. Without such studies, it is difficult to gauge rural health in the country.

As there have been few studies conducted in rural Pakistan, very little has been done to compare rural health across years. Many studies looking at health over time are, once

again, largely clinical-based.

With the inception of the Global Polio Eradication Initiative, many questions were raised as to the effect this program might have on the Expanded Programme on Immunization (EPI). Some researchers hypothesized that by increasing their focus on the Oral Polio Vaccine (OPV), all other immunization efforts would suffer; the administration of other vaccines such as the Bacillus of Calmette and Guerin (BCG), Diphtheria Pertussis and Tetanus (DPT) and the Measles Containing Vaccine (MCV) would drop, thereby resulting in a subsequent increase in these diseases.

This study will make use of some of the hard-to-come-by rural population data, and, in an attempt to address the aforementioned issues, will seek to compare immunization uptake[i] across study years, with some focus on examining polio uptake.

1.3 Research Objectives and Study Questions

OBJECTIVE 1: To determine and compare complete and age-appropriate immunization uptake in children up to three years living in Sindh, Pakistan.

1. What was the coverage of age-appropriate and complete immunization among children aged birth to 9 and 12 to 36 months, respectively, in 1994 and 1997 in Sindh, Pakistan?
    a. What was the immunization coverage of BCG, Polio, DPT, and MCV in children in rural Pakistan in 1994?

[i] *Uptake* refers to the percentage of children from the study sample who have received the BCG, DPT, OPV, and MCV immunizations; the terms *coverage* and *uptake* will henceforth be used interchangeably.

b. How does this coverage compare to that in the same rural population in 1997?
c. Do the rates vary from district to district?
d. Do the rates vary by sex of child?

OBJECTIVE 2: To determine the correlates of complete and age-appropriate immunization in children up to three years living in Sindh, Pakistan in 1997.

2. What are the correlates (*e.g.* sex of child, parents' education, district of residence, socio-economic status, *etc*.) of complete and age-appropriate immunization among children living in rural Pakistan?

1.4 Study Significance

Although Pakistan has proven to be in great need of research in the area of childhood immunizations, very little has been done to accommodate this need. Moreover, there is a growing interest in building capacity within the country to address these concerns (4). This study will attempt to accommodate both of the aforementioned issues: it will aid in bringing the issue of childhood immunizations to the attention of the research community, while making use of data that was collected by knowledgeable local researchers.

CHAPTER 2

LITERATURE REVIEW

This literature review seeks to provide an overview of immunization as it relates to Pakistan and those diseases associated with this study: polio, tuberculosis, diphtheria, pertussis, tetanus, and measles.

2.1 Health For All and the Eradication of Disease

Nineteen seventy eight was a landmark year for global health; it was then that the Alma Ata Declaration on Health was made and the WHO and UNICEF took an unprecedented stance in declaring Health for All by the year 2000 (5). The goal of this declaration was not necessarily to eliminate disease, but rather to push for the equitable distribution of health care resources among social and economical groups, and urban and rural populations.

Since the declaration was made, many efforts have been aimed at increasing the worldwide immunization of children. The WHO has been especially involved in the disease eradication process – polio is one of their targets. In order to declare a disease eradicated, the WHO has developed a certification process which must be done at the local, national and global levels. Eradication status is obtained only after the number of

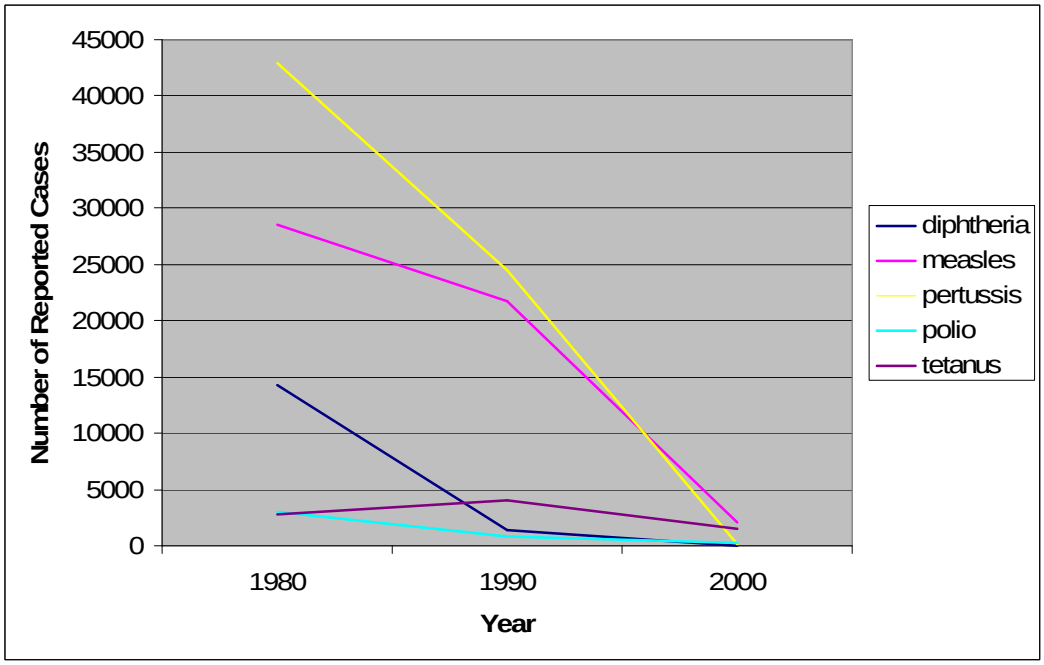
incident cases remains zero for a minimum period of three years. It is believed that if no new cases arise over this period, the population is then safe from the disease and it is declared to be "eradicated" from that region, country, or continent.

2.2 The Need for Childhood Immunizations in Pakistan

In 1990, infectious diseases were responsible for over 55% of deaths among the world's global poor (6). In order for the LDCs that house the global poor to reach the levels of the world's global rich, an estimated 92.1% reduction in these deaths would need to occur (6), most of which would be among children under 14 years. Through the use of stringent immunization programs, this reduction may be possible.

In 1974, the WHO began the Expanded Programme on Immunization (EPI) in an effort to fight tuberculosis, diphtheria, tetanus, pertussis, measles, and polio (7). The EPI program began immunizing children in Pakistan on an experimental basis in 1978 (7, 8). After preliminary results were analyzed, the program projected that over three million cases and nearly 250,000 deaths would be prevented by 1990 (9). Indeed, the introduction of the EPI program in Pakistan has resulted in a statistically significant reduction of reported cases (see Figure 2.1). There is still, however, much that can be done.

Figure 2.1 Number of Reported Cases of Vaccine-Preventable Diseases in Pakistan



* Created using data from the World Health Organization's (WHO) Immunization Profile of Pakistan (1).

Recent publications have listed Southeast Asia, for example, as having one of the greatest populations at risk of developing tuberculosis (10). With deaths from this disease numbering over one million people annually in Southeast Asia alone (10), countries such as Pakistan are fighting an uphill battle in trying to keep this disease under control.

In 1999, the WHO reported over 7,100 cases of polio worldwide, but expressed a fear that many cases were misdiagnosed or underreported (11). Constant surveillance of this preventable disease led the World Health Assembly to declare a Global Polio Eradication Initiative in 1988; Pakistan joined the eradication efforts in 1994 (12).

While the disease still exists in the world today, these efforts have not gone unnoticed. Primarily found in Africa, the Middle East, and South Asia, these efforts have shown a significant decrease in overall rates. As of December 27, 2005, there were 1,719 identified global cases of polio; twenty-five of which were found in Pakistan (13). Although polio was still recognized as being endemic to Pakistan in 2004 (Appendix B), there were great hopes that the last case in Pakistan would be seen in 2005.

2.3 Poliomyelitis

First described in Egyptian carvings, *poliomyelitis* has exhibited its wrath against humankind for centuries. In 1840, German orthopedist Jakob Heine was the first to medically document this disease (14). Since then the disease, often referred to simply as 'polio', has played a historically important role in the understanding of infectious diseases and the development of preventative and rehabilitative technologies (*e.g.* immunization, the iron lung, orthopedic devices, reconstructive surgery).

Affecting primarily children and young adults, this highly infectious disease is spread through direct person-to-person contact. The virus most often infects its new host through the mouth as a result of fecally contaminated water or food. Caused by one of three polioviruses, symptoms may range from headache, fever, sore throat, and muscle stiffness, to paralysis of limbs, breathing difficulty, and death (15, 16, 17).

The first polio vaccine was discovered in 1950 by Hilary Koprowski. Although this oral vaccine was never used in public health efforts because of safety concerns, it paved the

way for the development of Dr. Jonas Salk's injectable vaccine and Dr. Albert Sabin's oral vaccine – both of which were later used in immunization programs (16). To date, there remains no cure for polio, although prevention measures are becoming more and more effective.

In 2005, Pakistan reported 28 cases of polio (1). The WHO hopes to eradicate this disease in the coming years, and has increased its immunization efforts accordingly.

2.4 Tuberculosis

Another disease of great historical significance is *tuberculosis*. The earliest evidence of this disease has been found among the remains of Neanderthal skeletons and Egyptian mummies.

Tuberculosis is first and foremost a disease of the lungs. The virus is spread through direct human-to-human contact and manifests itself within the host by means of airborne droplets (from a cough, sneeze, *etc*.). The virus multiplies in the lungs and if the initial immune response fails to stop the spread, the central nervous system (CNS), lymphatic system, circulatory system, bones, and joints may also be affected.

Symptoms may include loss of energy, poor appetite, and listlessness (16). Severe coughing and the expectoration of sputum do not appear until months after the initial infection. Since the earlier symptoms are not unique to tuberculosis, diagnosis may be confirmed with the Manatoux skin test.

The tuberculosis vaccine, also known as the Bacillus of Calmette and Guerin, or BCG vaccine, was first developed in 1921 at the Paris Pasteur Institute by Albert Calmette and Camille Guerin, two French bacteriologists. The vaccine, which is not recommended for immuno-compromised individuals, is prepared from weakened bovine tuberculosis bacillus (16). Since its inception, over 100 million people have been vaccinated against tuberculosis using the BCG vaccine.

Developed countries are currently exhibiting such a low incidence of the disease (rates less than 1% per year) that use of this vaccine for childhood immunization is no longer recommended. The vaccine continues to be used, however, among professionals who are at risk of prolonged exposure (*e.g*. nurses) and individuals in LDCs where tuberculosis remains a health concern.

2.5 Diphtheria, Pertussis, and Tetanus

The DPT vaccine is a multipurpose vaccine, protecting against *diphtheria, pertussis* and *tetanus*.

Diphtheria is a bacterial disease that may take on an inhalational or cutaneous form. It is highly contagious and is transmitted from person-to-person; it may be carried in the mouth, nose, throat, or skin. Symptoms may include headache, fever, and sore throat, and may lead to difficulty breathing. Diagnosis may be confirmed by identifying the causal agent from a throat swab. The first diphtheria antitoxin was developed in the

1890s by Emil von Behring in Germany (18). This antitoxin, although not effective in killing the bacteria, was able to neutralize the toxins produced by the bacteria through the process of immunization. If contracted, diphtheria is now treated with antitoxins and bactericidal drugs (*e.g*. penicillin). Pakistan reported 23 cases of diphtheria to the WHO in 2005 (1).

Pertussis is more commonly known as the 'whooping cough', named for its characteristic 'whoop'. Symptoms include coryza and a persistent (and sometimes violent) cough. Afflicting primarily children under the age of one, roughly 90 percent of cases worldwide occur in LDCs (17, 19). The bacterium *Bordetella pertussis* is transmitted from person-to-person through airborne droplets. The first whole-cell pertussis vaccine was developed in 1926 by Louis W. Sauer in the United States (19). Acellular vaccines have since been developed which result in milder side effects. The WHO received 133 reports of pertussis in Pakistan in 2005 (1).

Tetanus is a highly fatal yet ultimately preventable, non-contagious disease that results when the *Clostridium tetani* bacterium secrets the tetanospasmin neurotoxin. First documented *circa* 5 B.C., the disease was not properly understood until Carle and Rattone discovered its etiology in 1884 (19). The bacterium, which may be found in agricultural soil and in the feces of a variety of farm animals, infects its host through breaks in the skin. Tetanus is more commonly known as lockjaw because this noticeable symptom is often seen among infected individuals. Other symptoms may include, but are not limited to: stiffness in the neck and back, risus sardonicus, difficulty swallowing,

muscle rigidity in the abdomen, fever, and diaphoresis. The disease is virtually unseen in immunized individuals. WHO reports indicate 697 cases of tetanus in Pakistan in 2005 (1).

The first DPT vaccine was developed in the 1930s and had a whole-cell pertussis component. The newer "mixed vaccine of formalin-inactivated diphtheria, tetanus toxoids, and pertussis vaccine" (16) now contains an acellular pertussis component. These two vaccines are often referred to as DTwP and DTaP, respectively.

2.6 Measles

The *measles* is a contagious disease that was once confused with smallpox. Important differences between the two were described by Ibn Al-Razi, a Persian physician, in the 10^{th} century (16). The measles virus is spread directly from person-to-person by airborne droplets. It is known to be highly contagious, infecting 90% of people (without immunity) who come into close contact with the infected person.

Symptoms may include fever, cough, coryza, conjunctivitis, Koplik's spots inside the mouth, a rash (which may itch) starting along the hairline and spreading over most of the body (16, 17). With an incubation period of 10-12 days (in which the patient is asymptomatic), the infected individual remains contagious until after the rash appears (15). No treatment (other than bed rest) is available for the measles.

The measles-containing vaccine (MCV) was available for use by 1963 (16). Despite the

uncommon existence of measles in more developed nations, it remains a health concern in LDCs (3). WHO statistics indicate that in Canada, for example, there were six reported cases of measles in 2005 (1). Over the same time period in Pakistan, however, 2,981 cases were reported (1).

2.7 Study Designs and Immunization Status: An Overview

A solid design and sound methodology is necessary for any good study. With respect to the collection of immunization data, four particular approaches are discussed in the literature: the EPI cluster survey, the systematic survey, Lot Quality Assessment Sampling (LQAS), and the review of medical charts.

First is the population-based EPI sampling design. The typical cluster survey seeking to assess immunization status requires that data from 30 clusters of 7 households (30 x 7) be collected (20, 21). This study design is often tedious and requires more time and effort to complete, compared to other methods. This design has been validated for the use of assessing immunization uptake. Even so, there is a possibility of running into certain design effect problems. This design, for example, is not suitable for collecting data on the prevalence of infectious diseases, as the diseases themselves often occur in clusters, and prevalence is likely to be over- or underestimated (21). The same weakness may be seen if immunization efforts are particularly high or low in a particular region. Additionally, population size cannot be estimated. Finally, although the original 30 x 7 cluster design cannot be used to present the correlates of immunization, this may be achieved with some slight modifications to the methodology.

Another study design that has been shown to yield comparable results in estimating immunization uptake (21) is the systematic survey. This design differs from the cluster survey in that households are selected through the use of a fixed sampling interval, and that interviewers move systematically through the sample area, collecting data from all streets in the entire zone. This method allows for the estimation of population size, and has been argued to provide a more representative sample than that achieved in the cluster survey (21). Unfortunately, the systematic nature of this methodology becomes somewhat less systematic when surveying areas where streets are not clearly defined. As a result, cluster surveys often become the method of choice when exploring rural areas.

A third study design often used to measure immunization uptake is the Lot Quality Assurance Sampling (LQAS). Originating from the manufacturing industry, this type of methodology seeks to determine acceptable immunization coverage of a town, for instance, based on the sampling of only a few townspeople (22). Sample size and quality assurance decisions vary from study to study, and the researcher must carefully weigh the possibility of making Type I and Type II errors while making such decisions. This methodology, while not suitable for ascertaining correlates of immunization, is adequate for determining whether or not the sample area is under-serviced with regards to immunization efforts.

One final method for assessing immunization coverage is the review of medical and

administrative data. First, medical charts, while often used as a source of information in more affluent nations, are not appropriate for research in the context of LDCs. Especially in the realm of rural health, medical charts are often unavailable. The use of administrative data therefore becomes more appealing. By simply dividing the number of administered doses by the number of eligible children, immunization coverage may be estimated (23). As with the LQAS, however, this method is of only real use when assessing uptake; correlates of immunization cannot be assessed. The modified cluster survey method therefore reemerges as the design most suited to measuring uptake and the independent variables associated with it.

2.8 Assessing Immunization Status: Validity and Reliability of Parental Recall

Typically when a child receives their first set of immunizations, the doctor provides the child's parents with an immunization card – a chart for which all future immunizations can be recorded on. In many cases, however, this record is often lost or misplaced. For low-income families, this paper may mean they can start a fire in the winter time, or use it as scrap paper. When it comes time to report on their child's past immunizations, parents must often report the event from memory.

Many studies have been done to assess the validity and magnitude of recall bias in the reporting of immunization status. In 2002, a Scottish study was published about parental recall of measles mumps rubella (MMR) vaccination in their children (24). A survey was administered to the parents of 171 reportedly unvaccinated children (according to medical charts), and the percent agreement between records and recall was assessed.

The authors found that many parents of the unvaccinated children believed that they had, in fact, been vaccinated (24). Immunization based on parental recall is often overestimated (25). A separate study in India sought to measure recall bias in the estimation of immunization coverage of 774 children. Parents were asked to report on the status of their child's DPT, OPV, BCG, and measles immunizations. Fewer than 50% of mothers reported having kept the immunization cards. For those cards that were available, over 70% were incomplete. Sensitivity and specificity of recall was reported to be 41.3% and 79.5%, respectively (26). The respondent's (mother's) age was correlated with degree of bias. Although this particular study found the sensitivity to be lower than ideal, a more recent study concluded that parental recall is more sensitive than data from immunization cards in retrospective studies (27). The authors advised that recall be "accepted as reasonably reliable in the absence of cards" (27).

2.9 Defining Immunization Status

When assessing immunization status, the sensitivity and specificity of parental recall have been shown to present problems in obtaining valid, dose-specific data. As a result, more general reporting measures have been adopted in the literature. Rather than reporting immunization status for each dose, studies often report a child's immunization status as being "complete", "partial", or "age-appropriate". These methods may be more likely to reduce the biases inherent in cases of recall. Moreover, the information may be more relevant and appropriate to the study questions and analysis. An infant, for example, who has had his first round of immunizations, would be more appropriately categorized as "age-appropriate" immunization attained, rather than immunization

"incomplete".

When assessing immunization status, international organizations such as the WHO and UNICEF use complete and age-appropriate categorizations. Using the WHO/UNICEF Joint Reporting methods, complete or full immunization is defined as all children aged 12 to 36 months who have received all recommended doses (BCG, DPT3, OPV3, MCV) of immunization. The same Joint Reporting format defines age-appropriate or infant immunization as children under 12 months who have received BCG, DPT, OPV and MCV doses appropriate to their age in months (28).

2.10 Benefits, Barriers and Risk Factors Affecting Immunization Uptake

Recent studies have recognized such things as religion, education, place of residence, number of children in the household, employment status of the parents, and distance to the nearest health facility to all be predictors of immunization (29, 30, 31, 32). Lack of time and motivation on behalf of the parent, and unavailability of a vaccine at the closest facility have been identified as being potential barriers to childhood immunization (7, 29).

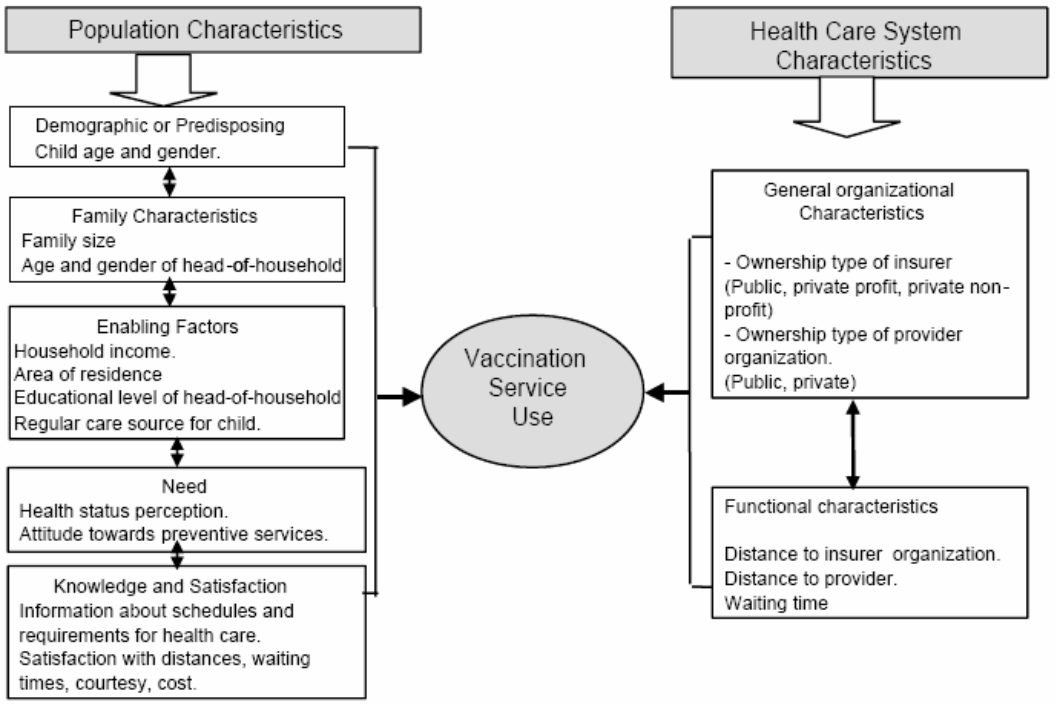
2.10.1 Andersen's Model of Determinants of Healthcare Use

In the early 1970's, Ronald Andersen created a framework for the study of access to healthcare services (33). This framework has been widely used to explain the use of an array of healthcare services, including immunization availability and uptake. Although the model has been modified over the years, three general principles embedded in the

framework have remained constant over time: predisposing factors (*i.e.* age, sex, education level, health beliefs), enabling factors (*i.e.* income, insurance, regular sources of care), and need (34). Each of these three principles helps describe the characteristics of the population at risk and the likelihood that they will seek care.

In 2005, Acosta-Ramírez *et al.* (35) modified Andersen's Behavioural Model of Health Services Utilization to explore the determinants of immunizations in Colombia (Figure 2.2). Although the motives were somewhat political in nature, the principles used may be applied to this study of immunizations in Pakistan. The researchers used a cross-sectional study design, administering surveys across the city of Bogotá. They sampled notably poor localities. Dependent variables relating to predisposing factors, family characteristics, enabling factors, need, and knowledge and satisfaction of the immunization services were collected. Independent variables relating to health care system characteristics (*i.e.* public versus private services, distance to provider, wait times) were also collected. The following variables were associated with increased likelihood of immunization: belonging to a family of eight or more people, living in the East Central or South district, and having a head of house whose education amounted to four years or less (35). Knowing and understanding the immunization requirements was also a statistically significant predictor of uptake (35). As mainly poor localities were assessed, household income and socio-economic status (SES) was not found to be statistically significant in predicting immunization status. Many of these findings, especially those of family size, parental education and SES, are contrary to other studies that have sought to explore the determinants of immunization uptake.

Figure 2.2 Adapted Version of Andersen's Behavioural Model of Health Services Utilization



SOURCE: Acosta-Ramirez *et al.*, 2005 (35).

Other studies have found such things as large family size, low SES, and fear to be predictive of low immunization rates (36). In having a large number of children, it becomes a problem bringing them all along into town, and may be a hassle to alternatively find someone to watch the children for the day. It may also be problematic and not economically feasible to take a day off work to have their child immunized.

A recent evaluation of the EPI vaccination program in Nepal, for example, found coverage levels to be approximately at or above herd immunity levels (30). The same study examined the effect of parental education as a determinant of childhood

immunization status. As the parent's education level increased, so too did the children's level of immunization (non-immunized, partial or complete) (30). Similarly, a 1992 study in India on immunization coverage demonstrated overwhelming evidence that by providing parents with educational materials on health, nutrition, and the importance of childhood immunization, immunization rates would jump to nearly three times the rates of the control group; the greatest increase was noted among the urban population (37).

When speaking to the role of SES in immunization uptake, most studies find that a low SES is indicative of lower uptake levels. Despite these often overwhelming findings, there are studies scattered throughout the literature that show the reverse effect of SES on immunization uptake. One study, for example, sought to explore the relationship between economic status and immunization uptake in children aged 19 to 35 months, residing in the United States (38). Using data from the 2003 National Immunization Survey (NIS), SES, among other demographic variables, was assessed. The researchers found that, unlike so many other studies, low SES was associated with high uptake levels (38). One potential explanation of this finding relates to the location of study. The United States, being a more affluent nation, has undoubtedly more resources and better coverage for their immunization efforts. LDCs lacking these resources tend to find that the opposite is true. Recent studies in India (39), Bangladesh (40), and Turkey (41), for example, all found that low SES was associated with poor uptake levels. In India, SES was determined by income levels. Low SES was found to be a predictor of low immunization coverage in both urban and rural populations (39). This trend was evident when stratifying by sex and was apparent in both study periods: 1992-3 and 1998-9. In

Bangladesh, food security status was used as a measure of economic status. Researchers found that children living in households with a food surplus reported almost 50% higher immunization uptake levels than children residing in food deficit households (40). The Turkish study found that the odds of children with a high SES background being fully immunized were 2.41 times the odds of children from low SES backgrounds (95% CI= 1.034, 1.657) (41). It is expected that the data from this Pakistan study will reflect the findings of other LDCs, as presented, above.

One final predisposing factor in the Andersen model that has not yet been discussed is gender. Much research has been done in the way of gender and immunization. In most studies examining correlates of immunization, sex of the child is often the first thing discussed. Although some studies have found that gender is not a statistically significant predictor of uptake, the general consensus among researchers is that if a difference is found, it is that males are more likely to be fully-immunized than females (42).

One study of children in India reported full immunization in terms of the gender gap, stratifying for SES and rural or urban residences (39). The results were overwhelming. In 1999, rural residents at all levels of SES combined showed a 2.81% gap in immunization uptake across sexes, with males being more likely to be fully-immunized (39). While this may not sound large, statistical analyses revealed that the gap was statistically significant at $p<0.01$ (39). The gender gap among urban residents was even larger at 4.03%, $p<0.01$ (39). The same study revealed that overall, the gender gaps in both rural and urban areas have increased from 1993 to 1999 (39).

2.10.2 The Health Belief Model

Another framework that has been useful in explaining health-seeking behaviour is that of the Health Belief Model (HBM) (43). This psychological model states that health behaviours are a function of three main factors: individual perceptions, modifying factors, and likelihood of action. The HBM has been used to explain preventative health behaviours, and may be applied to the topic of immunization.

In order for someone to seek preventative medicine, individuals must:

1. believe that the negative health outcome (*e.g.* measles, polio, tetanus) is a perceived threat and that it may be prevented;
2. expect that by taking preventative measures (*i.e.* being immunized) that the negative health outcome will be avoided;
3. feel comfortable and confident in the treatment regime (*i.e.* immunization); feel that the benefits will outweigh any potential negative outcomes (44).

To this end, parental beliefs play a large role in whether or not their children are immunized. Failure to recognize any of the above criteria will decrease the likelihood of immunization uptake. Furthermore, parents showing fears of needles (36), fear of side effects, or lack of comfort with Western medicine (45) may also cause them to shy away from seeking routine immunization for their children.

2.10.3 The Rural Context

Located in southeast Pakistan, Sindh is a relatively rural area of the country and has most of its inhabitants living in rural and remote areas. Studies have shown that rural areas are more likely to have more un-immunized children and fewer fully-immunized children than urban populations (29, 39, 40, 46). Often, this discrepancy is due to such factors as: a lack of transportation to the nearest health centre, inadequate funds to pay for travel, inability to travel due to poor road conditions, and the inability of a parent to leave some children at home while bringing others to be immunized. These factors have long been identified as being potential barriers to immunization that are specific to rural populations. Immunization efforts have therefore recognized the need to offer door-to-door or village visits in such areas in order to reach the more remote communities (12).

2.11 Gaps in the Literature

Through the analysis of the literature, it has become apparent that there are certain gaps that are not being addressed. First and foremost, it is obvious that Pakistan – especially rural Pakistan – is not a focus in the literature. When doing a Medline (OVID) online search, combining the terms "Pakistan" and "immunization" reveal only five articles. Moreover, two of these articles focus only on Karachi, a large urban centre. None of the articles deal specifically with rural populations. None of the articles speak exclusively of the use and uptake of BCG, OPV, DPT, or MCV.

Additionally, the data that is currently available regarding immunizations is often clinical in nature. Counts taken from immunization programs is one common way of assessing

immunization status. Very few studies, however, use an on-the-ground population-based approach. While cluster survey designs offer some relief to the problem, there are, as mentioned previously, many generalizations made when using this technique, which make the exact determination of correlates difficult.

This study, will address each of these gaps. While using population-based survey results from rural Pakistan, an effort will be made to assess the immunization uptake of diseases that – although not prevalent in more affluent countries – still plague less-developed-countries like Pakistan.

CHAPTER 3

METHODOLOGY

Data for this study were collected as part of two cross-sectional studies in Sindh, Pakistan: 1) in 1994 through the School Nutrition Program (SNP) and; 2) in 1997 as part of the Family Health Project (FHP).

3.1 Sample

Data was collected in Sindh, Pakistan – one of the country's four provinces. Sindh is administratively divided into 18 districts. Immunization data from the SNP and FHP surveys were available from four of these districts: Thatta, Tharparkar, Badin, and Mirpur Khas. All families residing in these districts were potential survey participants.

Assuming a confidence level of 95%, it was estimated that 2000 children were needed to obtain an adequate study sample. Data were collected until the appropriate study sample was achieved. SNP and FHP collected immunization data on 1877 and 1694 children, respectively. A summary of sample size collected in each district is shown, below (Table 3.1).

Table 3.1 Summary of data collected

Study (n)	District, n (%)			
	Thatta	Tharparkar	Badin	Mirpur Khas
School Nutrition Program (1877)	415 (22.1)	522 (27.8)	480 (25.6)	460 (24.5)
Family Health Project (1694)	449 (26.5)	412 (24.3)	429 (25.3)	404 (23.9)

3.2 Method

Funded by the Norwegian Agency for International Development and the World Bank, the SNP project sought to address the issues of illiteracy and malnutrition in Thatta, Tharparkar, Badin, and Mirpur Khas. By contrast, the FHP project sought to strengthen the existing public health system by: increasing child and maternal health, reducing the incidence of infectious disease, and providing an opportunity for increased capacity building and inter-institutional collaboration. This project was also funded by the World Bank.

3.2.1 Data Collection Procedures

The immunization status of children (< 3 years) was collected as part of the baseline surveys for both SNP and FHP (see APPENDIX C and D). These cross-sectional studies employed the use of a stratified random sampling, whereby each district was divided into strata (villages) and simple random samples (households) were selected from within each stratum.

The proportion to population size (PPS) technique was used to select households for the

study. Prior to the selection of individual households, a population profile of the study districts was completed. For each participating village, the total number of households was counted. The number of households subsequently surveyed from each village was proportionate to the size of that village. More households were selected from larger villages than from smaller ones.

Following the population profile, the selection of households continued with the creation of a map of each participating village. Important landmarks were included (*e.g.* church, store, school); one was subsequently chosen, at random, to serve as the starting point. At the selected landmark, a bottle was spun. After coming to a stop, the mouth of the bottle indicated the direction in which researchers would proceed. Researchers visited the first house they came upon. Subsequent houses were chosen based on proximity (that is, the second house visited was that which was closest to the first, the third house was that which was closest to the second, *etc*.). This process was repeated until the household study sample was met for that stratum.

All surveys were administered by trained interviewers. The term "trained interviewers" refers to a selected group of females with grade 10 education who were recruited from the community for the purpose of these studies. Prospective interviewers attended three days of training workshops. Those who successfully completed this training became certified interviewers for the studies. Inter-rater reliability was monitored by Masters-level social scientists through the supervision of interviews.

For each household, the mother or guardian provided verbal consent to the survey. In the event that the mother or guardian was not available, two further attempts were made to contact them. In each household, all children three years and under were included in the survey. Since many birth certificates were not available, age was estimated according to relevant local events.

Where available, the child's immunization status for each of eight shots (1 BCG, 3 OPV, 3 DPT, 1 Measles) was determined based on their immunization card. In cases where the immunization record was not available, immunization status was assessed based on the mother's recall.

In addition to immunization information, data on many socio-demographic variables were also collected. Such variables include household economic status (based on monthly income, type and size of house, material possessions), and education and health-seeking behaviour of the mother (*i.e.* use of breast-feeding, oral rehydration solution, utilization of health care services).

3.2.2 Data Sources

Both SNP and FHP datasets were accessed through the principal investigator, Dr Syed Shah. The datasets were shared following ethics approval for the project.

3.2.3 Ethics and Measures of Confidentiality

Data were stored in locked filing cabinets and secure computer files. Original survey responses were not available. All identifying information was removed from the data; subjects were coded using household and personal identifiers. Only aggregate data were reported.

Prior to analysis, ethics approval was sought from the Biomedical Science Research Ethics Board at the University of Saskatchewan. On April 26, 2006, this work was deemed exempt from approval due to the de-identified nature of the data (see Appendix E).

3.3 Study Variables

Immunization status was the outcome variable of interest. Independent variables included measures of socio-economic status, sex of child, and district of residence.

3.3.1 Dependent Variables: Defining Immunization Status

The SNP and FHP surveys collected immunization information on eight vaccines: BCG, OPV1, OPV2, OPV3, DPT1, DPT2, DPT3, and MCV. Using the survey responses "yes", "no", and "don't know", the variables were dichotomized into simple "yes" or "no" answers. Using these responses, complete and age-appropriate immunization status was derived. Immunization status was coded according to current definitions, as recognized in the literature and as used by such international organizations as UNICEF and the WHO. A summary of these definitions is presented in Table 3.2.

Table 3.2 Defining Immunization Status

Term	Child Age	Definition
Age-Appropriate or Up-to-Date	birth - 9 months	Number of children who have received all recommended doses for their age. Specifically, birth - 2 months having BCG; 3 - 5 months having BCG, OPV1, DPT1; 6 - 8 months having BCG, OPV3, DPT3; and 9 months having BCG, OPV3, DPT3 and measles.
Not Age-Appropriate or Not Up-to-Date	birth - 9 months	Number of children who are missing one or more recommended doses for their age.
Complete	12 - 36 months	Number of children who have received all of the recommended doses of BCG, OPV, DPT and measles.
Incomplete	12 - 36 months	Number of children who are missing one or more doses of BCG, OPV, DPT and/or measles.

The majority of the analysis uses these dichotomized immunization data as the dependent variables. These outcome variables refer to "Vaccination Service Use" in the modified conceptual model discussed in Chapter 2 (35).

3.3.2 Independent Variables

Not all survey variables were available for analysis. As a result, most of the remaining independent variables were used, where appropriate.

For the first part of the analysis – comparing immunization uptake across study years – three independent variables were used as a means of comparison: sex of child, age of child, and district of residence. The subsequent analysis of correlates used the independent variables listed in Appendix F. Most variables were coded in categorical form. Where appropriate, independent variables were dichotomized. Each of these independent variables fits under "Population Characteristics" in the conceptual model discussed in Chapter 2 (35).

3.4 Data Management and Analysis

Data analysis was completed using SPSS 14.0 statistical software.

3.4.1 Data Cleaning

Prior to analysis, the data required much attention with regards to cleaning. The SNP dataset came with no labels or variable coding information. Much time and effort was spent assuring the variables were coded correctly. Where doubt existed, it was recommended that the analyses of previously published papers using the dataset be re-run (47, 48). In doing so, the variables could be coded in accord with prior work on the dataset. After coding and labeling the variables, some inconsistencies were found in the data (*e.g.* two variables coding child age, showing different distributions). When such inconsistencies were encountered, advice from the principal investigator was sought. With this SNP dataset, it was also found that not all children possessed a unique household identifier. That is, there were multiple children per household. Since this dataset was not to be used in the multivariable analysis of correlates of immunization, none of the children was excluded from the analysis.

The FHP dataset presented similar problems. Without a proper code book, labeling and coding variables had to be done very carefully, consulting with the study's primary investigator. With regards to immunization, the FHP data contained questions about nine potential shots – one more than that in the SNP data. Since the time of the SNP survey, an inoculation of OPV at birth was introduced in Pakistan, bringing the OPV

shots up to four. Upon running a preliminary descriptive analysis, however, it was found that the status of this OPV shot was only available in one of the four districts surveyed (*i.e.* Mirpur Khas). Using this in the definition of complete/incomplete and age appropriate immunization status meant that the results were being skewed strongly toward incomplete or not up-to-date. As a result, it was decided to omit the OPV at birth shot from the FHP analysis.

3.4.2 Descriptive Analyses

A descriptive analysis on immunization status was conducted for both (1994 SNP and 1997 FHP) datasets. The data were broken down by sex of child and district of residence for each survey. Cross tabs and Pearson's chi-square significance levels were reported. This allowed for a general reporting of how the data were distributed.

3.4.3 Research Objective 1: Immunization Uptake in 1994 and 1997

Comparison of immunization uptake across study years was conducted. This analysis began by comparing the uptake of each of eight vaccines (BCG, OPV1, OPV2, OPV3, DPT1, DPT2, DPT3, and MCV) in males and females across study years. Cross tabs were done and Pearson's chi-square significance levels reported.

Complete and age-appropriate immunization uptake was subsequently analyzed. Using the dichotomized immunization data, cross tabs and Pearson's chi-square values were reported with specific attention to uptake between sexes and districts.

Using the complete and age-appropriate data, trends in immunization uptake across years were noted. Again, specific focus was put on uptake between sexes and districts.

3.4.4 Research Objective 2: Analysis of Correlates

Logistic regression is a widely accepted and used method of determining which independent variables are statistically significant predictors of a dependent variable's outcome. Hosmer and Lemeshow (49) are often referenced for their comprehensive look at how to use regression models; a modified computer-driven version of their methods is used here.

Since each of the children in the FHP dataset contained a unique household identifier, and the outcome variable was dichotomous, it was decided that logistic regression was an appropriate form of multivariable analysis to determine correlates of immunization. Four major steps were taken in this stage of the analysis.

STEP 1: Bivariate analyses were carried out using the FHP data. These analyses were done to evaluate each survey variable for its unadjusted association with complete and age-appropriate immunization status. Independent variables with a p-value <0.20 in the bivariate analysis were to be included in the multivariable logistic regression models.

STEP 2: Identifying independent variables to use in the multivariable analyses. Since there were a number of statistically significant SES-related variables, there was some concern that some had the same distribution as others, thereby demonstrating

collinearity. In an effort to reduce the number of SES variables entered in the multivariable model, tests were done to ensure the distributions were different. A series of 2 x 2 tables were created in order to assess the similarities of distribution; chi-square and significance values were assessed. In the event that no statistically significant difference was observed, only one of the two variables was chosen for the multivariable model.

STEP 3: Model building was used to determine which correlates were statistically significantly in affecting immunization outcome; the forward selection option was used. Two models were created during this step of the analysis, using independent variables from step 1 ($p<0.20$). The first was created to assess the correlates of complete immunization in children aged 12 to 36 months. The second model was to assess the correlates of age-appropriate immunization in children birth to nine months.

STEP 4: In this fourth and final step, Hosmer's Goodness of Fit test was conducted. In this step, the null hypothesis being tested is: the model adequately fits the data. If the null hypothesis is rejected, the model should be re-examined. By contrast, if the null hypothesis is not rejected, the model is deemed to adequately fit the data.

CHAPTER 4

RESULTS

4.1 Characteristics of Study Subjects

Since the initial focus of the SNP and FHP surveys was to increase health, many socio-demographic variables were collected, but only a limited number of the collected variables revealed personal demographic or predisposing information about the study children. Age and sex are two of these variables.

The following figures show the breakdown of males and females by survey year and health district (Figures 4.1 and 4.2). The results reveal a relatively equal distribution of males and females within each district. No statistically significant difference was found between sexes (Pearson Chi-Square=3.298, df=3, p=0.348) in the SNP data. Similarly, the FHP data showed no statistically significant difference in sex across districts (Pearson Chi-Square=2.336, df=3, p=0.506).

Figure 4.1 Child's sex by District, 1994 SNP Survey

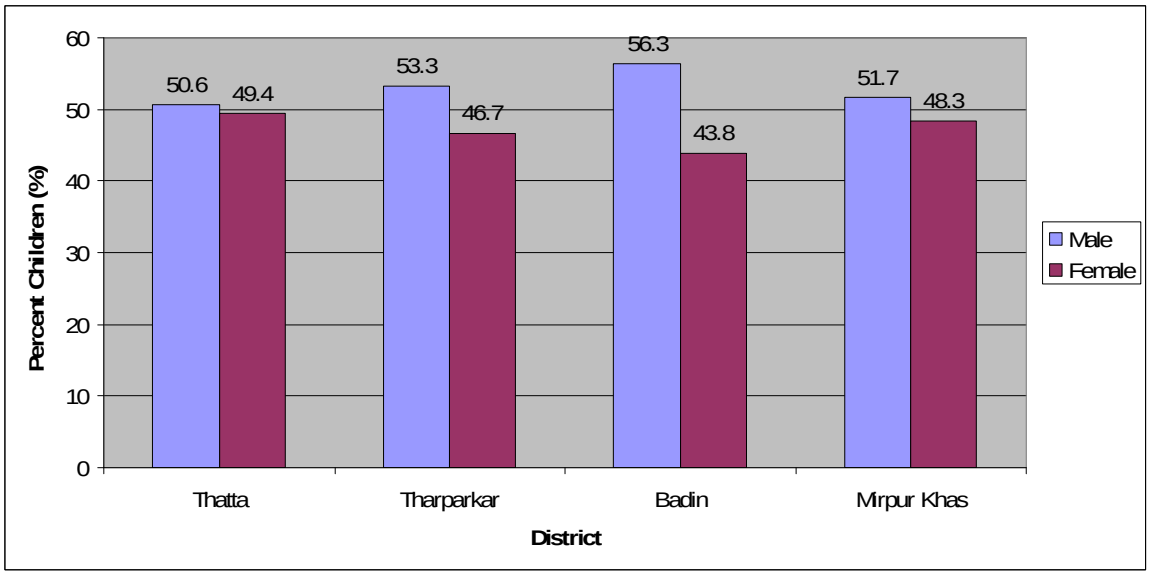
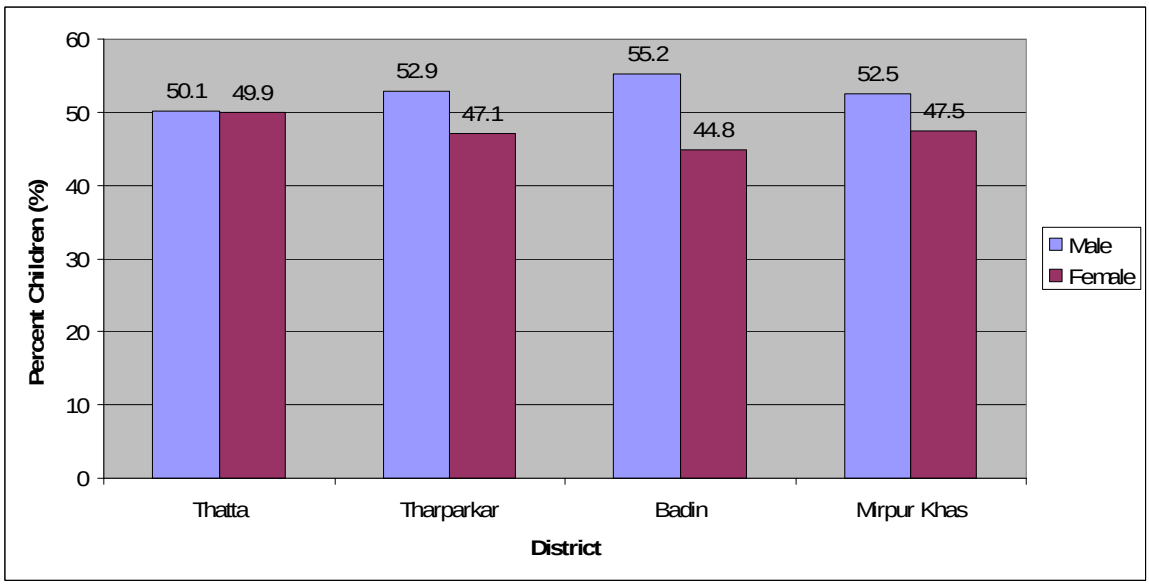


Figure 4.2 Child's sex by District, 1997 FHP Survey



Age of the children was an important variable in determining immunization status. Below is a summary of the study children's ages by survey year and district (Table 4.1, Table 4.2).

Table 4.1 Child Age by District, 1994 SNP Survey

Independent Variable	District, n (%)			
	Thatta	Tharparkar	Badin	Mirpur Khas
Child Age	**415 (100.0)**	**522 (100.0)**	**480 (100.0)**	**460 (100.0)**
0-11 months	115 (27.7)	155 (29.7)	144 (30.0)	152 (33.0)
12-23 months	114 (27.5)	149 (28.5)	123 (25.6)	124 (27.0)
24-36 months	186 (44.8)	218 (41.8)	213 (44.4)	184 (40.0)

Table 4.2 Child Age by District, 1997 FHP Survey

Independent Variable	District, n (%)			
	Thatta	Tharparkar	Badin	Mirpur Khas
Child Age	**449 (100)**	**412 (100)**	**429 (100)**	**404 (100)**
0-11 months	137 (30.5)	169 (41.0)	65 (15.2)	151 (37.4)
12-23 months	116 (25.8)	119 (28.9)	61 (14.2)	121 (29.9)
24-36 months	196 (43.7)	124 (30.1)	303 (70.6)	132 (32.7)

As noted in tables 4.2 and 4.2, the majority of the children fall into the 24 to 36 month age category; much fewer children are under 12 months of age. This will result in a large sample size in the analysis of complete immunization, and a smaller sample for age-appropriate immunization.

4.2 Research Objective 1: Immunization Uptake in 1994 and 1997

Immunization status was assessed based on the survey responses for each of the eight vaccines. Survey responses for all children and districts are summarized in Table 4.3.

As expected, the number of children who have received OPV and DPT immunizations decreases with each successive dose in both males and females. Fewer females are shown to have been immunized than males for each of the eight immunizations in 1994 (approximately 2% less in SNP). The FHP data, however, reveals slightly different trends. In 1997, females and males appear to have been immunized nearly equally for many of the recommended doses (BCG, OPV1, DPT2). For the doses of OPV2, OPV3, DPT3, and MCV, uptake in males is only slightly higher than in females (approximately 1%). Moreover, in the dose of DPT1, females actually show a slightly higher uptake than that of their male counterparts (41.4% females versus 39.2% in males). The equalization of immunization uptake across sexes from 1994 to 1997 was expected.

The uptake of each vaccine was compared across sexes in a series of two-by-two tables. Although some differences in sex are observed, none of these differences was found to be statistically significant ($p>0.05$) (Table 4.3).

Table 4.3 Vaccine Coverage Among Children birth to 36 months in Sindh, Pakistan 1994 and 1997

Vaccine	1994 SNP, ALL Districts, n (%)				1997 FHP, ALL Districts, n (%)			
	Males		Females		Males		Females	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
BCG	679 (72.6)	256 (27.4)	588 (70.1)	251 (29.9)	411 (47.4)	456 (52.6)	374 (47.6)	412 (52.4)
OPV1	706 (75.5)	229 (24.5)	621 (73.8)	221 (26.2)	491 (55.7)	391 (44.3)	444 (55.7)	353 (44.3)
OPV2	619 (67.6)	297 (32.4)	537 (64.7)	293 (35.3)	404 (46.2)	471 (53.8)	360 (45.5)	432 (54.5)
OPV3	493 (54.7)	409 (45.3)	427 (52.7)	383 (47.3)	334 (38.3)	539 (61.7)	288 (36.6)	499 (63.4)
DPT1	567 (61.3)	358 (38.7)	513 (60.9)	329 (39.1)	344 (39.2)	534 (60.8)	327 (41.4)	463 (58.6)
DPT2	493 (54.1)	418 (45.9)	436 (52.8)	390 (47.2)	309 (35.4)	563 (64.6)	276 (35.1)	510 (64.9)
DPT3	466 (51.8)	434 (48.2)	398 (49.1)	412 (50.9)	278 (32.0)	590 (68.0)	240 (30.7)	543 (69.3)
Measles	419 (47.6)	462 (52.4)	367 (45.4)	441 (54.6)	231 (27.5)	610 (72.5)	190 (25.3)	561 (74.7)

The following tests assess the differences between sexes for the uptake of each vaccine.

Pearson's Chi-Square Significance, SNP

BCG p=0.238	DPT1 p=0.873
OPV1 p=0.396	DPT2 p=0.578
OPV2 p=0.204	DPT3 p=0.275
OPV3 p=0.421	Measles p=0.379

Pearson's Chi-Square Significance, FHP

BCG p=0.942	DPT1 p=0.358
OPV1 p=0.987	DPT2 p=0.891
OPV2 p=0.769	DPT3 p=0.547
OPV3 p=0.484	Measles p=0.328

In order to more accurately assess immunization coverage, complete and age-appropriate immunization status was assessed for children over 12 months, and birth through nine months, respectively. A summary of complete immunization coverage is presented in Table 4.4.

Table 4.4 Complete Immunization Coverage by Sex

Vaccine Status	1994 SNP, All Districts, n (%)		1997 FHP, All Districts, n (%)	
	Males (555)	Females (482)	Males (605)	Females (536)
Complete	320 (57.7)	260 (53.9)	190 (31.4)	148 (27.6)
Incomplete	235 (42.3)	222 (46.1)	415 (68.6)	388 (72.4)
	Chi-Square=1.445 df=1 p=0.229		Chi-Square=1.961 df=1 p=0.161	

Although fewer females have attained the status of being completely immunized, immunization coverage is similar among males and females within each dataset. Neither SNP nor FHP show statistically significant differences among sex ($p>0.05$). Interestingly, complete immunization coverage is shown to have decreased from 1994 to 1997 (57.7% to 31.4% in males and 53.9% to 27.6% in females).

A similar analysis for age-appropriate immunization is presented in Table 4.5.

Table 4.5 Age-Appropriate Immunization Coverage by Sex

Vaccine Status	1994 SNP, All Districts, n (%)		1997 FHP, All Districts, n (%)	
	Males (212)	Females (213)	Males (239)	Females (232)
Age-appropriate	74 (34.9)	90 (42.3)	23 (9.6)	40 (17.2)
Not up-to-date	138 (65.1)	123 (57.7)	216 (90.4)	192 (82.8)
	Chi-Square=2.421 df=1 p=0.120		Chi-Square=5.896 df=1 p=0.015	

As there are fewer children in the younger age category, the lower samples here reflect that. Unlike the complete immunization coverage, this age-appropriate coverage indicates that more females are up-to-date on their immunizations than their male counterparts. This trend is visible in both the SNP and FHP datasets. This finding, while not significant in 1994 ($p>0.05$) is statistically significant within the 1997 FHP data ($p<0.05$).

In the 1994 SNP data, a statistically significant difference was found in complete immunization status between districts ($p<0.001$) (Table 4.6). The number of children categorized as being completely immunized was higher than those categorized as incomplete in the districts of Badin (66.7%) and Mirpur Khas (73.6%); the reverse is observed in Thatta (40.8%) and Tharparkar (43.2%).

The same data revealed no statistically significant difference in age-appropriate immunization status across districts ($p>0.05$). Age-appropriate immunization uptake ranged from 30.3% in Thatta to 45.9% in Tharparkar. Interestingly, Tharparkar, which holds one of the lowest levels of complete immunization, also boasts the highest levels of age-appropriate immunization. Results are presented in Table 4.6.

Table 4.6 Immunization Status by District, 1994 SNP Survey

District (n)	Immunization Status* n (%)		Age-Appropriate Immunization** n (%)	
	Complete	Incomplete	Yes	No
Thatta (415)	106 (40.8)	154 (59.2)	27 (30.3)	62 (69.7)
Tharparkar (522)	114 (43.2)	150 (56.8)	51 (45.9)	60 (54.1)
Badin (480)	170 (66.7)	85 (33.3)	41 (37.6)	68 (62.4)
Mirpur Khas (460)	190 (73.6)	68 (26.4)	45 (38.8)	71 (61.2)
	Chi-Square=86.421 df=3 p<0.001		Chi-Square=5.138 df=3 p=0.162	

***Immunization Status for children 12-36 months**
****Age-appropriate status for children up to and including 9 months**

The FHP data show similar trends (Table 4.7). A statistically significant difference was found when comparing complete immunization status across districts ($p<0.01$), while the age-appropriate immunization status only revealed borderline significance across districts ($p<0.10$). In this data, however, the number of children categorized as having complete immunization was lower than those categorized as incomplete in each of the four districts; the same trend is evident in age-appropriate status (see Table 4.7).

Table 4.7 Immunization Status by District, 1997 FHP Survey

District (n)	Immunization Status* n (%)		Age-Appropriate Immunization** n (%)	
	Complete	Incomplete	Yes	No
Thatta (449)	111 (37.4)	186 (62.6)	25 (20.3)	98 (79.7)
Tharparkar (412)	31 (13.2)	204 (86.8)	16 (10.5)	119 (89.5)
Badin (429)	118 (33.1)	238 (66.9)	6 (9.8)	55 (90.2)
Mirpur Khas (404)	78 (30.8)	175 (69.2)	16 (11.9)	119 (88.1)
	Chi-Square=41.289 df=3 p<0.001		Chi-Square=7.122 df=3 p=0.068	

***Immunization Status for children 12-36 months**
****Age-appropriate status for children up to and including 9 months**

Thatta, which has the highest levels of complete uptake (37.4%), also has the highest levels of age-appropriate immunization (20.3%). Although Badin shows high levels of complete uptake (33.1%), the same district has the lowest age-appropriate uptake (9.8%).

When examining complete immunization uptake from 1994 (Table 4.6) to 1997 (Table 4.7), some unexpected results reveal themselves. In each of the four districts, complete uptake is shown to have decreased across study years. The decrease ranges from as little as 3.4% in Thatta, to as much as 42.8% in Mirpur Khas. Age-appropriate uptake shows a similar decline from 1994 to 1997. Age-appropriate status in children is shown to have decreased by 10.0% in Thatta, 35.4% in Tharparkar, 27.8% in Badin, and 26.9% in Mirpur Khas.

4.3 Research Objective 2: Correlates of Complete and Age-Appropriate Immunization in 1997

A bivariate analysis was conducted to assess the individual effect of each independent variable on immunization status. In this analysis, using complete immunization status as the outcome variable, many independent variables were found to be statistically significant at $p<0.20$ (Table 4.8). The odds of complete immunization were 0.162 in females, compared to males. Also, the odds of complete immunization were less for those who did not own a radio, TV, refrigerator, washing machine (*etc*.) than in those who did own one or more of the above.

The bivariate analysis of age-appropriate immunization status also revealed many independent correlates ($p<0.20$), including: sex of the child, knowledge and use of contraception, district of residence, as well as a number of SES indicators (Table 4.9). As in the FHP dataset, many of the statistically significant variables represent socio-economic status of the child's family.

There was some concern that using too many measures of SES in the multivariable modeling would result in inappropriate results. A series of cross-tabulations was therefore done for each pair of independent variables (*e.g.* radio and TV, radio and refrigerator, TV and refrigerator, *etc.*). Pearson's chi-square was used to assess any similarities between variables. Each of the tests revealed statistically significant differences ($p<0.01$) between the variables. As a result, each independent variable that was demonstrated to have a statistically significant effect ($p<0.20$) on the outcome variable in the bivariate analysis was included in the full regression analysis.

Child's sex, use of contraception, health district of residence, and an array of SES indicators were therefore included in the multivariable modeling of complete immunization.

Table 4.8 Bivariate Analysis for Complete Immunization (ages 12 to 36 months)

Independent Variable		Complete n (%)	Incomplete n (%)	Unadj. OR	95% CI for β Lower	95% CI for β Upper	p-value
Child's sex	Male	190 (16.6)	415 (36.4)	1			
	Female	148 (13.0)	388 (34.0)	0.162	0.645	1.076	**0.162***
Deaths last 5 years	Yes	41 (3.6)	94 (8.2)	1			
	No	297 (26.0)	709 (62.2)	0.960	0.650	1.420	0.840
Where Seek Health Care	Gov't	137 (12.1)	305 (27.0)	1			
	Private Clinic	201 (17.9)	485 (43.0)	0.923	0.711	1.197	0.544
Radio	Yes	128 (11.3)	183 (16.0)	1			
	No	210 (18.4)	620 (54.3)	0.484	0.368	0.637	**<0.001***
TV	Yes	84 (7.4)	78 (6.8)	1			
	No	254 (22.3)	725 (63.5)	0.325	0.232	0.457	**<0.001***
Refrigerator	Yes	41 (3.6)	14 (1.2)	1			
	No	297 (26.0)	789 (69.2)	0.129	0.069	0.239	**<0.001***
Washing Machine	Yes	32 (2.8)	7 (0.6)	1			
	No	306 (26.8)	796 (69.8)	0.084	0.037	0.193	**<0.001***
Water Pump	No	42 (3.7)	15 (1.3)	1			
	Yes	296 (25.9)	788 (69.1)	0.134	0.073	0.246	**<0.001***
Air Conditioner	Yes	14 (1.2)	1 (0.1)	1			
	No	324 (28.4)	802 (70.3)	0.029	0.004	0.220	**0.001***
Motorcycle	Yes	25 (2.2)	22 (1.9)	1			
	No	313 (27.4)	781 (68.5)	0.353	0.196	0.635	**0.001***
Car/van	Yes	25 (2.2)	21 (1.8)	1			
	No	313 (27.4)	782 (68.6)	0.336	0.185	0.609	**<0.001***
Electricity	Yes	187 (16.4)	271 (23.8)	1			
	No	151 (13.2)	532 (46.6)	0.411	0.317	0.533	**<0.001***
Bicycle	Yes	49 (4.3)	47 (4.1)	1			
	No	289 (25.3)	756 (66.3)	0.367	0.240	0.559	**<0.001***
LHW Visit	Yes	82 (7.2)	92 (8.1)	1			
	No	256 (22.4)	711 (62.3)	0.404	0.290	0.562	**<0.001***
Overcrowding	No	99 (9.2)	186 (17.3)	1			
	Yes	223 (20.7)	567 (52.8)	0.739	0.554	0.986	**0.04***
House Type	Pucca	118 (10.3)	133 (11.7)	1			
	Kucha	220 (19.3)	670 (58.7)	0.370	0.277	0.495	**<0.001***
Heard of Contraception	Yes	202 (17.7)	470 (41.2)	1			
	No	136 (11.9)	333 (29.2)	0.950	0.734	1.231	0.699
Use Contraception	Yes	51 (4.5)	72 (6.3)	1			
	No	287 (25.2)	730 (64.0)	0.555	0.378	0.815	**0.003***
Health District	Thatta	111 (9.7)	186 (16.3)	1	-	-	**<0.001***
	Tharparkar	31 (2.7)	204 (17.9)	0.255	0.163	0.397	**<0.001***
	Badin	118 (10.3)	238 (20.9)	0.831	0.602	1.147	0.260
	Mirpur Khas	78 (6.8)	175 (15.3)	0.747	0.523	1.066	**0.108***

***p<0.20**

Table 4.9 Bivariate Analysis for Age-Appropriate Immunization (ages birth to 9 months)

Independent Variable		Up-to-date n(%)	Not Up-to-date n(%)	Unadj. OR	95% CI for β		p-value
					Lower	Upper	
Child's sex	Male	23 (4.8)	216 (45.9)	1	1.131	3.386	**0.016***
	Female	40 (8.5)	192 (40.8)	1.957			
Deaths last 5 years	Yes	9 (1.9)	51 (10.8)	1	0.399	1.841	0.693
	No	54 (11.5)	357 (75.8)	0.857			
Where Seek Health Care	Gov't	36 (7.7)	182 (39.3)	1	0.366	1.071	**0.087***
	Private Clinic	27 (5.8)	218 (47.1)	0.626			
Radio	Yes	22 (4.7)	96 (20.4)	1	0.326	1.010	**0.054***
	No	41 (8.7)	312 (66.2)	0.573			
TV	Yes	12 (2.5)	35 (7.5)	1	0.195	0.818	**0.012***
	No	51 (10.8)	373 (79.2)	0.399			
Refrigerator	Yes	9 (1.9)	6 (1.3)	1	0.031	0.261	**<0.001***
	No	54 (11.4)	402 (85.4)	0.090			
Washing Machine	Yes	7 (1.5)	5 (1.0)	1	0.030	0.323	**<0.001***
	No	56 (11.9)	403 (85.6)	0.099			
Water Pump	No	5 (1.1)	6 (1.2)	1	0.051	0.585	**0.005***
	Yes	58 (12.3)	402 (85.4)	0.173			
Air Conditioner	Yes	1 (0.2)	1 (0.2)	1	0.009	2.467	**0.185***
	No	62 (13.2)	407 (86.4)	0.152			
Motorcycle	Yes	4 (0.8)	12 (2.6)	1	0.140	1.432	**0.175***
	No	59 (12.5)	396 (84.1)	0.447			
Car/van	Yes	3 (0.6)	9 (1.9)	1	0.119	1.713	0.242
	No	60 (12.7)	399 (84.8)	0.451			
Electricity	Yes	29 (6.1)	152 (32.3)	1	0.408	1.188	**0.184***
	No	34 (7.2)	256 (54.4)	0.696			
Bicycle	Yes	5 (1.1)	28 (5.9)	1	0.317	2.302	0.756
	No	58 (12.3)	380 (80.7)	0.855			
LHW Visit	Yes	15 (3.2)	63 (13.4)	1	0.308	1.107	**0.099***
	No	48 (10.2)	345 (73.2)	0.584			
Overcrowding	No	14 (3.2)	96 (21.6)	1	0.608	2.180	0.666
	Yes	48 (10.8)	286 (64.4)	1.151			
House Type	Pucca	14 (3.0)	67 (14.2)	1	0.359	1.316	0.258
	Kucha	49 (10.4)	341 (72.4)	0.688			
Heard of Contraception	Yes	29 (6.2)	236 (50.1)	1	0.944	2.741	**0.080***
	No	34 (7.2)	172 (36.5)	1.609			
Use Contraception	Yes	10 (2.1)	34 (7.2)	1	0.225	1.032	**0.060***
	No	53 (11.3)	374 (79.4)	0.482			
Health District	Thatta	25 (5.3)	98 (20.8)	1	-	-	**0.075***
	Tharparkar	16 (3.4)	136 (28.9)	0.461	0.234	0.909	**0.026***
	Badin	6 (1.3)	55 (11.7)	0.428	0.165	1.106	**0.080***
	Mirpur Khas	16 (3.4)	119 (25.3)	0.527	0.266	1.043	**0.066***

***p<0.20**

Using the statistically significant variables of the bivariate analysis (child's sex, radio, TV, refrigerator, washing machine, water pump, air conditioner, motorcycle, can/van, electricity, LHW visit, overcrowding, house type, and health district), a logistic regression model was created to assess the correlates of complete immunization status. A forward regression method was used.[ii] Variables in the final model included those with $p<0.05$. The main effects of the regression model for complete immunization are presented in Table 4.10, below.

Table 4.10 Multivariable Model (Main Effects) for Complete Immunization (ages 12 to 36 months), n=1074

Independent Variable (reference)	OR	95% CI for β		p-value
		Lower	Upper	
CONSTANT	13.804	-	-	<0.001
Radio (yes)	0.713	0.507	1.002	0.051
Water Pump (no)	0.360	0.172	0.755	**0.007***
Electricity (yes)	0.674	0.473	0.962	**0.030***
Bicycle (yes)	0.570	0.353	0.918	**0.021***
LHW Visit (yes)	0.489	0.315	0.759	**0.001***
House Type (pucca)	0.637	0.437	0.930	**0.020***
Health District (Thatta)				**<0.001***
Tharparkar	0.290	0.179	0.472	**<0.001***
Badin	0.599	0.420	0.854	**0.005***
Mirpur Khas	0.271	0.169	0.433	**<0.001***

***p<0.05**

Hosmer-Lemeshow Goodness of Fit: Chi-square = 5.746 df = 6 sig. = 0.452

[ii] Although a forward regression model was used, many regression methods (e.g. backward, enter) were tested; all yielded similar results.

In this model, not owning a radio or bicycle and not having electricity were indicative of lower odds of complete immunization. Similarly, those who did not have a LHW visit the home had decreased odds of complete immunization. Those children living in kucha (temporary, not concrete) homes were also at decreased odds of being completely immunized, compared to children living in pucca (permanent, concrete) homes. Children in the Thatta district had the greatest odds (OR=1) of being completely immunized.

The Hosmer and Lemeshow Goodness of Fit test yielded a significance of 0.452. Since $p>0.05$, the null hypothesis was not rejected; this model is considered to adequately fit the data.

A similar regression model was created using the statistically significant variables from the bivariate analysis (child's sex, where seek health care, radio, TV, refrigerator, washing machine, water pump, air conditioner, motorcycle, electricity, LHW visit, heard of contraception, use contraception, and health district) to explore the correlates of age-appropriate immunization status. The main effects included: child's sex, ownership of refrigerator, and having heard of contraception (Table 4.11).

Table 4.11 Multivariable Model (Main Effects) for Age-Appropriate Immunization (ages birth to 9 months), n=463

Independent Variable (reference)	OR	95% CI for β		p-value
		Lower	Upper	
CONSTANT	0.892	-	-	0.842
Child sex (male)	1.851	1.050	3.262	**0.033***
Refrigerator (yes)	0.079	0.026	0.241	**<0.001***
Heard of Contraception (yes)	1.925	1.090	3.401	**0.024***

***p<0.05**

Hosmer-Lemeshow Goodness of Fit: Chi-square = 1.041 df = 2 sig. = 0.594

Interestingly, these results reveal that the odds of females being up-to-date on their immunization doses are 1.851 times the odds of males being up-to-date. Those children who do not have a refrigerator in the house are at decreased odds of having age-appropriate immunization. Finally, those children whose parents have not heard of contraception are 1.925 increased odds of being immunized for their age, compared to children whose parents have not heard of at least one form of contraception.

The Hosmer and Lemeshow Goodness of Fit test for the age-appropriate immunization model had a significance of 0.594. As with the complete immunization model, since $p>0.05$, the null hypothesis was not rejected and this model is therefore considered to fit the data well.

CHAPTER 5

DISCUSSION

The results presented in the previous chapter often coincide with the published literature on correlates of immunization and expected immunization uptake. The following will provide some insight into and explanation of these results.

5.1 Immunization Uptake in 1994 and 1997

The WHO keeps records of the percentage of children immunized. Coverage surveys are conducted every few years, and country estimates fill in the gaps. According to their own data, the country estimates show consistently higher estimates than the results of the coverage survey, with the exception of OPV. In 2001, the estimates were as follows (Table 5.1):

Table 5.1 WHO Estimates of Immunization Uptake in Pakistan, 2001

Vaccine	Coverage Survey (%)	Country Estimate (%)	% Difference
BCG	67	93	-26
DPT1	71	86	-15
DPT3	63	76	-13
OPV3	89	74	15
MCV	57	75	-18

*Table created using WHO data (1).

Keeping this in mind, an attempt may be made to compare WHO country estimates for 1997 with those presented in Chapter 4 of this thesis. According to the WHO (50), the reported immunization coverage is as follows:

- BCG, 90%
- DPT3, 74%
- OPV3, 77%
- MCV, 74%

These results are much higher than those reported in Table 4.3. This study finds that BCG uptake is 47.4% for males and 47.6% for females. Similarly, DPT3 is 32.0% for males, 30.7% for females, OPV3 is 38.3% for males and 36.6% for females, and MCV is 27.5% for males and 25.3% for females. So why is it that the results found here are in no way comparable to those rates reported by the WHO? The answer here is remarkably simple, although not immediately obvious. We are measuring two different things. In this study, the aim was to report the crude immunization uptake levels. These values represent the immunization status of all children surveyed. In the WHO reports, however, the numbers reflect the percentage of *targeted* population that was immunized. Each year, the WHO selects a target population which will receive immunization coverage. The target population is not all children, and does not include all geographic areas. The measures they report are therefore meant to reflect the success of their immunization efforts for that particular year. Readers should take note of this difference in reporting and be weary when making comparisons between this data and that of the WHO.

Turning now to the comparison of immunization uptake between study years (1994 and 1997); we see that the results show an overall decrease in coverage levels. Given the immunization efforts of the WHO, it seems counterintuitive that coverage should drop. The substantial decreases in complete and age-appropriate immunizations among males and females (Tables 4.4 and 4.5) cannot be explained merely by the over- or underestimation of individual immunization status alone. There are a number of possible explanations for this observed decrease. First, we may speculate that there may have been a change in funding for the EPI program in Pakistan. Although no evidence of this has been found, any decrease in funding may have resulted in a corresponding decrease in immunization coverage. Second, there may have been a change in the targeted populations. As mentioned previously, the populations targeted by the WHO to receive the year's allotment of immunizations may change from year-to-year. It is plausible that more immunization efforts were being supported in the areas of Thatta, Tharparkar, Badin and Mirpur Khas in 1994 than in 1997. This may also explain why some districts experienced greater decreases in immunization coverage than others (Tables 4.6 and 4.7). A third and well-documented theory is the change in immunization focus. The international health community expressed great concern when, in 1988 the Global Polio Eradication Initiative was created (12). The declaration had good intentions and sought only to eradicate the disease worldwide. Concerns arose, however, from the idea that the OPV vaccine would take priority over other immunization efforts. Health workers and researchers worried that the polio eradication efforts would therefore hinder coverage of BCG, DPT and MCV (51). Pakistan joined the polio eradication initiative in 1994. Coverage seems to have dropped between 1994 and 1997. The

concern of the polio efforts overshadowing other immunization campaigns seems unlikely in these regions, however, as polio coverage did not seem to increase. It, along with BCG, DPT and MCV all dropped between study years (Table 4.3). While this theory cannot be entirely discounted, we would expect to see higher levels of OPV uptake in 1997 as the other immunization levels dropped.

5.2 Correlates of Immunization

Gender and markers of SES were the two main focuses in determining the correlates of complete and age-appropriate immunization. The following is a review and discussion of the results pertaining to these demographic variables and enabling factors.

5.2.1 The Gender Difference

The Expanded Programme on Immunization (EPI) in Pakistan has, without doubt, contributed to an increase in immunization uptake in all children (52). It has often been noted in the literature, however, that gender differences remain. Females, in general, seem to be immunized less often than their male counterparts. One study focusing solely on Pakistan notes that "substantial gender gaps remain only in rural Sindh" (52). This same study found that females aged 12 to 23 months were less likely to receive DPT3 and BCG immunizations than males of the same age, and were significantly less likely ($p<0.05$) to receive the recommended measles immunization (52).

This study collected immunization information on roughly equal numbers of males and females (Figures 4.1 and 4.2). When looking at specific doses, no statistically significant

differences were found in BCG, OPV, or DPT between genders (Table 4.3). This trend, including children aged birth to 36 months, was apparent in both SNP and FHP datasets. Unlike the study summarized above, however, there was no statistically significant ($p<0.05$) difference in uptake of measles vaccine between genders in 1994 or 1997.

When exploring gender differences, it may be more appropriate to examine complete and age-appropriate immunization coverage. The former, examining children aged 12 to 36 months, showed no statistically significant differences in either 1994 ($p=0.229$) or 1997 ($p=0.161$) (Table 4.4). The latter, aimed at evaluating the uptake of children aged birth through nine months, only showed a statistically significant gender gap ($p=0.015$) in the 1997 dataset (Table 4.5). The bivariate analysis of sex on immunization outcome found females have lower odds of complete immunization (OR=0.162), but higher odds of age-appropriate immunization (OR=1.957). The subsequent multivariable regression analysis revealed that gender only played a role in the immunization of children less than nine months (Table 4.11). In this case, females had higher odds of immunization (OR=1.851) than their male counterparts.

If gender gaps are so often noted in the literature, why then does gender only play a role in the early doses of immunization in Sindh, Pakistan? The answer may be explained, in part, by the WHO's support of the EPI.

Throughout the 1970s and 1980s, the EPI program was proven to be very effective in increasing immunization to LDCs and reducing disease in those areas. As a result,

additional resources were committed in the 1990s to step up the immunization efforts. Special attention was being paid to eradicating polio. The EPI program went into the villages in an effort to immunize all eligible children. The program does not discriminate due to gender. Disease can affect anyone and, as such, both males and females are given the doses appropriate to their age.

Since the EPI does not have a constant presence in any one village, children may be born and not immediately immunized. The initial immunizations at birth are therefore often the responsibility of the parents. As the EPI health workers return to the villages, all unimmunized children receive the 'catch-up' doses they require. Females and males return to more equal immunization levels, therefore offering a potential explanation to the more similar coverage levels among the older children.

The higher observed levels of age-appropriate immunization in females is harder to explain. Although most research seems to find that males are more likely to receive medical treatment than females, the reverse trend is apparent in this study. It would be interesting to see if this trend remains true for the treatment of ailments and disease in the same rural area of Pakistan. Perhaps parents in these regions are coddling their female children more than their male children – including seeking out certain medical treatments. Maybe the results are somewhat artifactual and parents are more likely to overestimate the recall of females being immunized than males. To discover the exact reason, additional information not available here would be required.

5.2.2 The Role of Socio-Economic Status as a Correlate of Immunization

The results presented in Chapter 4 are, for the most part, as expected when discussing the effect of SES on immunization uptake. Previous research has shown that those families who have a higher SES are more likely to have their children immunized than low-SES families. In both the bivariate (Tables 4.8, 4.9) each regression analysis (Tables 4.10, 4.11), this was found to be true.

Why is it that families living in houses with fewer amenities, who have more irregular contact with health workers, and who have apparently lower levels of education are also those who are less likely to be immunizing their children? Again we turn to the EPI program for an explanation of these results. The WHO recognizes that lower SES families often have a greater difficulty in paying for transportation, health care fees and child care when bringing one of their often many children to be immunized. Rural residents have an even greater difficulty in traveling into town to seek such services. The EPI program, however, cannot be deployed to each small rural village – this would be costly and time-consuming. As a result, the lowest of low-SES families may be continuing to receive poor immunization coverage. With this explanation, the regression results from this study may be explained. Children aged 12 to 36 months were less likely to be immunized (Table 4.10) if the family did not own a radio (OR=0.713), did have a water pump (OR=0.360), did not have electricity (OR=0.674), did not own a bicycle (OR=0.570), did not have a LHW visit the home (OR=0.489), living in a kucha house (OR=0.637), or lived in the districts of Tharparkar (OR=0.290), Badin (OR=0.599), or Mirpur Khas (OR=0.271).

Younger children, between birth and nine months, were more likely to be immunized (Table 4.11) if the child was female (OR=1.851), the family did own a refrigerator (OR=1) and the mother had not heard of contraception (OR=1.925).

5.3 Exploring the Modified EPI Two-Stage Cluster Survey Sampling Method

This study employed the use of a stratified random sampling technique, with proportion to population size (PPS) methods. This methodology for household selection is similar to that of the EPI random walk method. Developed by the WHO in 1978 (22), notable characteristics of the EPI method include:

- Selection of communities using PPS;
- Selection of households by interviewers in the field;
- Using a sample size of '30 x 7' (30 clusters of seven children each);
- Not returning to non-response houses (53).

The WHO often refers to this methodology (also called the 'two-stage cluster survey technique') when discussing the estimation of immunization coverage (21). Step one of the data collection involves the random sampling of 30 clusters. Clusters may represent geographic or political boundaries (22). Using PPS, clusters with larger populations have a higher chance of selection. Step two of the two-stage technique sees the selection of seven children for each of the 30 clusters. After randomly selecting the first household, subsequent houses are visited based on proximity to the first. Immunization data from the seven individuals is pooled to estimate coverage for that cluster.

While this method is one that has been used in numerous studies, it is not without its faults. First, this method assumes that members within each cluster possess similar traits and are therefore not entirely independent of one another (53). In making this assumption, researchers may justify using only seven individuals to estimate coverage for the cluster. This assumption may be inaccurate if the geographic region is large or spread out. Second, in the event that there is a non-response (*e.g.* the home owners are not at home when the researcher calls), the researchers do not return to the house at a later time. This may lead to additional bias in the study, as non-responders may differ from responders. Third, the researchers choose households in the field based on proximity. Unconscious bias of the researcher may alter the route. Use of a sampling frame would be preferred.

In an effort to reduce the inherent bias of this study, the researchers of this study decided to modify the data collection methods. First, it was decided that PPS techniques would be used to select households within each stratum. Larger villages would therefore mean that more individuals were surveyed. Samples were not limited to seven children per cluster. Second, researchers chose to return to homes in the event of a non-response. Interviewers would return on two separate occasions in the attempt to reach the home owners. Only after these attempts were proven to be unsuccessful did the researchers give up. This was important in reducing bias. Finally, although the researchers were keen on choosing households in a fair and unbiased way, sampling frames were not available for all rural and remote villages. As a result, this portion of the data collection

methodology remained unchanged from the original EPI random walk method.

While the 30 cluster technique is often used for estimating immunization coverage, and is a valid method for collecting such information, the investigators of this study recognized that certain geographic characteristics also made the two-stage cluster survey an unrealistic choice. Most notably, this study was spread over a large population, living in very diverse environments. Over four provinces, data from 18 districts was collected. Each district was further divided into smaller villages. Individual villages differed in local employment opportunities, religious and family beliefs, as well as environmental factors. As each of these has the potential to affect immunization uptake, the investigators found it necessary to evaluate uptake levels in as many villages as possible. The 30 cluster technique, had it been used here, is not likely to have captured an accurate picture of immunization uptake in the area. The clusters, when chosen at random, may not have covered each district as thoroughly as was desired.

Finally, and most notably, the stratified random sampling technique with PPS was chosen over the two-stage cluster survey technique because it was better suited to the collection and analysis of correlates of immunization. The 30 x 7 cluster survey, while useful in estimating immunization coverage, is not appropriate for the analysis of correlates. The investigators of the 1994 SNP and 1997 FHP studies were quite keen on measuring demographic variables and enabling factors and therefore decided that the stratified sampling methods, which may be used to collect information on potential correlates, was a better choice.

In using this modified technique, the investigators were able to not only tailor the methodology to better suit the study, but are also confident that in doing so, the inherent bias of the study was reduced.

5.4 Study Limitations

As with all studies, this one has its limitations. First, in using previously collected data, the statistical analyses done for this project was limited to the study variables collected in the survey. The author of this thesis, for example, was interested in measuring the immunization uptake and subsequently comparing that to incidence of disease in the same area. Disease information, however, was unavailable, and thus the analyses of the study were guided by which variables were available.

With respect to external validity, this study may not be generalized to a greater population since the study population is unique. The participants of the surveys were all rural residents. As research has shown differences in rural and urban populations, it would be inappropriate to generalize these findings to urban areas of Pakistan. Moreover, as this study was conducted in an LDC in which polio remains endemic, generalization cannot be made to more developed countries where such diseases are not viewed as problematic or where children are not immunized for these diseases.

When discussing the time frame of this study, it is important to note that since the data was collected some years ago and the WHO has since put more stringent immunization

measures into place since then, the results may not reflect the current state of childhood immunizations in Sindh, Pakistan.

One important piece of information that has been lost in the study files over the years is the question of response rate. While the primary investigator has indicated that response rate for those who were successfully contacted was very good, exact numbers remain a mystery, as does the answer to the question: how many households that were approached participated in the survey (*i.e.* not simply those who were contacted successfully)?

Inherent in the cross-sectional study design is also recall bias and the inability to show causality. As discussed earlier, parental recall on immunization status has been studied in some depth. Despite the possibility of overestimation, parental recall is viewed as an acceptable source of such information.

Despite the aforementioned shortcomings of this study, the investigators remain confident that the information presented here is accurate and, at the very least, representative of the state of immunization in Sindh in the 1990's.

5.5 Future Directions

Vaccines have long been described as possibly "the greatest public health achievement of the 20th century" (54). There is no doubt that research into immunization coverage and efforts should continue. The author would therefore like to make some recommendations to improve upon future studies.

1. Future studies employing the use of survey data should make note of the response rate. In presenting this data and reasons for non-response, a more complete picture of the current uptake of immunization may be painted.
2. Collecting information about levels of disease. In this study, no information about prevalence of disease was available. It would be beneficial to compare immunization uptake by district to disease levels in those same areas, as immunization areas with higher disease rates may be potential targets for future EPI efforts. In making these comparisons, policy changes may be recommended.
3. Continuing to collect immunization information as part of the EPI program. It would be beneficial to continue to collect such information so that a trend analysis may be done to compare uptake from year to year. While it is important to analyze the success of the program by reporting percentage of the targeted population immunized, it is equally important to determine the percentage of the total population immunized.
4. Collecting additional information on population characteristics is recommended. It would be interesting to see the effects of additional family characteristics (*e.g.* family size, age and gender of primary caregiver), enabling factors (*e.g.* income, education of caregiver), and knowledge and attitudes on immunization status.

While the ideas listed above may be ambitious and costly, each would add another dimension to the information currently available for Pakistan and would therefore provide important information for policy makers concerned with international health and

immunization efforts.

5.6 Conclusions

This study sought to: 1) explore the uptake of complete and age-appropriate immunization across study years; and 2) determine the correlates of complete and age-appropriate immunization.

It was found that immunization uptake of individual vaccines, complete and age-appropriate immunization all decreased from 1994 to 1997. This trend was apparent across genders and districts.

Although each of the study areas shows a decrease in immunization uptake from 1994 to 1997, residents of Mirpur Khas and Tharparkar show the greatest drop in complete and age-appropriate immunization, respectively. This may be explained by the populations chosen to be targeted for immunization as part of the EPI program. Caution is advised when comparing these data to those of the WHO as the populations (*i.e.* the denominators) are different.

In accord with expectations, high SES (as measured by an array of material possessions) was a correlate of complete and age-appropriate immunization. District of residence was important to the complete immunization regression model, while sex of the child was only statistically significant in the age-appropriate model; females had higher odds of immunization uptake than males.

These results are expected to contribute to the growing body of literature on immunization uptake and correlates of complete and age-appropriate immunization.

Appendix A: Indicators of Health: A Comparison Between Pakistan and Canada (2003)

Health Indicators	Pakistan	Canada
GDP (per capita)	$1,920	$30,429
Life expectancy – Males	62.0 years	78.0 years
Life expectancy – Females	62.0 years	82.0 years
Child mortality – Males	98 per 100,000	6 per 100,000
Child mortality – Females	108 per 100,000	5 per 100,000
Adult mortality – Males	225 per 100,000	93 per 100,000
Adult mortality – Females	199 per 100,000	57 per 100,000
Dependency ratio	82 per 100	45 per 100

* Sources: World Health Organization (WHO) (55, 56).

Appendix B: Polio Eradication Maps, 1988 and 2004

AN INCREDIBLE ACHIEVEMENT FOR CHILDREN
MAP OF POLIO ENDEMIC COUNTRIES IN 1988:

AND IN 2004:

* Source: UNICEF. Immunization Plus: Eradicating Polio (57).

Appendix C: 1994 School Nutrition Program (SNP) Survey

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BASELINE SURVEY OF SCHOOL NUTRITION PROGRAM IN SIND

Date ___ / ___ / ___
Day ڏيهن Month مهينو Year سال

Interviewer's name _____
سوال پڇڻ واري جو نالو

Name of village _____ (1) SNP School _____
ڳوٺ جو نالو ايس اين پي اسڪول

Deh _____ Union Council _____
ديهه يونين ڪائونسل

Taluka _____ District _____
تعلقو ضلعو

Village Headman _____
ڳوٺ جو چيئرمين

Name of the head of household _____
خاندان جي وڏي جو نالو

Household number _____
خاندان جو نمبر

Name of the respondent _____
جواب ڏيندڙ جو نالو

Proxy respondent 1 [ ] Yes ها 2 [ ] No نه
عيوضي جواب ڏيندڙ

If proxy respondent, relation to sample person _____
جيڪڏهن عيوضي ڏيندڙ هو/هي نمونيدار شخص سان رشتو

Total number of family members in the household
خاندان ۾ سڀ فردن جو تعداد

A1. Age of respondent 30
جواب ڈیندڑ جي عمر

A2. Education of the respondent? ---I--- (Write code)
جواب ڈیندڑ جي تعليم کوڈ لکو

1. Can not read and write — لکي پڑهي نٿو سگهي
2. Can just read and write — صرف لکي پڑهي سگهي ٿو
3. Class 1 to 5 — ڪلاس پهرين کان پنجين تائين
4. Class 6 to 10 — ڪلاس ڇهين کان ڏهين تائين
5. Intermediate. — انٽر
6. Graduate — گريجوئيٽ
7. Other (Specify). — بيو ڪو

A3. Is the father or gaurdian of children employed?
ڇا بارن جو پيءُ/سرپرست نوڪري ۾ آهي؟

1. [ ] Yes ها
2. [✓] No نه
3. [ ] Don't know خبر نه آهي

A4. What is the occupation of father/guardian?
پيءُ/سرپرست جو ڌندو ڪمرو آهي؟

1.---------- (Mention occupation) هتي ڌندو لکو
2. [ ] Don't know خبر نه آهي

(2)

A5. Does the father of children owns land?
ڇا پيءُ وٽ زمين آهي؟

1. [ ] Yes ها 2. [✓] No نه (Go to A8) جيڪڏهن نه ته A8 ڏانهن وڃو

A6. What is the nature of the land ? زمين جهڙي آهي؟

1. [ ] His own land پنهنجي ذاتي
2. [ ] Government lease لئز تي زمين
3. [ ] Hari هاري
4. [ ] Other (specify)-------- ٻيو

A7. What is the type of land? زمين جهڙي قسم جي آهي؟

1. [ ] Fertile (by irrigation) آباد (آبپاشي وسيلي)
2. [ ] Fertile by rain (Barani) آباد (برسات وسيلي)
3. [ ] Desert رڻ پٽ. بيابان
4. [ ] Other (specify) ٻيو هجي

A8. What is the average monthly income of the family?
خاندان جي ماهوار سراسري آمدني هيتري آهي؟

1000 (Mention in rupees)
(روپين ۾ لکو)

A9. What is the type of housing construction?
گهر جي اڏاوت جهڙي قسم جي آهي؟

1. [ ] Pucca (concrete) پڪو (سيمينٽ سان)
2. [ ] Semi Pucca ڪچو پڪو
3. [ ] Kucha-mud ڪچو. گاري سان
4. [ ] Kucha reed ڪچو. ٽٻڙ جو ٿيل
5. [✓] Mud and wood ڪچو. ڪاٺ ۽ ڪاڻ

A10. What is the number of rooms in this household?
گهر ۾ ڪمرن جو تعداد

1 (Write number)
هتي انگ ۾ لکو

A11. How many family members do you have in this household? گھر خاندان میں پانچ جو تعداد جیتروں کرتی ہی؟

[4] Write total number. (کل پانچ جو تعداد لکو)

A12. How many children do you have under 5 years of age?
توھاں کی پنجن سالن جی عمر جا کیترا بار آدن؟

1 ---------- (total number of children)
(بارن جی کل تعداد)

A13.

SN	Name نالو	Age عمر Years/Months سال مھینہ / دن ھیئہ سال	Sex جنس Male=M, جوھرو Female=F جوھري
1		1 7	M
2			
3			
4			

B. Birth and Breast feeding History for the oldest child under 3 years of age
تن سالن جي الندرو ڏي بار جي جنم ۽ ڇيڻ بيمارڪ متعلق معلومات

B1. Name, age and sex of the oldest child under 3 years of age ?
تن سالن تائين ميڙ ان وڏي بار جي نالو، عمر، جنس ۽

Name نالو _____ Age عمر ------/------/ years سال months مھينا

Sex جنس 1 M= Male جوھرو F= Female جوھري

B2. Where was the child born? ٻار جو جنم ڪٿي ٿيو هو؟

1 [ ] Home گهر ۾ 2 [✓] Hospital اسپتال ۾ 3 [ ] MCH Center ماءُ ٻار واري صحت مرڪز ۾

4 [ ] Other (specify) _____ (وضاحت ڪريو) ٻيو ڪجهه

B3. Who attended/assisted the delivery?
وليڊ ڪنهن ڪرايو/ڪنهن جي مدد سان ٿيو؟

1 [ ] Relative عزيز (رشتيدار) 2 [ ] Dai دائي 3 [ ] Mid wife سکيا ورڪر ميڊوائيف

4 [ ] LHV ليڊي هيلٿ وزيٽر 5 [ ] Doctor ڊاڪٽر/ڊاڪٽرياڻي 6 [ ] Other -- (specify) ڪو ٻيو

B4. At birth, how was the weight of child (mother's perception)? جنم وقت ٻار جو وزن ڪيترو هو؟

1 [✓] Normal weight مناسب وزن 2 [ ] Under weight (small) گهٽ وزن
3 [ ] Over weight (large) وڌيڪ وزن 4 [ ] Don't know خبر نه آهي

B5. Was the child ever breast fed?
ٻار کي ڪڏهن ڇاتي پياري وئي هئي؟

1 [✓] Yes ها 2 [ ] No نه (Go to B8) (B8 ڏانهن وڃو)

B6. Did you give the baby the colostrum (local word)?
ڇا توهان ٻار کي ڇاتيءَ جا جمريا ٽوها (سيئڙ) پياري ڏني؟

1 [ ] Yes ها 2 [✓] No نه
3 [ ] Don't know خبر نه آهي

B7. At what age of the baby will you/did you stop breast
ٻار جي ڪهڙي عمر ۾ توهان ڇاتي بند ڪندؤ/ڪئي ڏڻي؟

feeding?---2---4------ (months) (Go to B8) 4 Less Than 6 months
ياريون مهينا (B8 ڏانهن وڃو)
(جيڪڏهن 6 مهينن کان گهٽ آهي)

B8. Why was the baby not breast fed?
بار کي چاجي هڙي تيڇ نه پياري وئي ؟

1 [ ] Baby refused بار پاڻ هڙ نه پيتو
2 [ ] Illness of baby بار بيمار هو
3 [ ] Illness of mother ماءُ بيمار هئي
4 [ ] Insufficient milk تيڇ گهٽ هئي
5 [ ] Other (Specify) ----------

B9. At what age of the baby will you /did you start
بار کي هڙي عمر ۾ توهان کاڏو کارائيندا شروع هندو/ شروع ڪيو ؟

supplementary foods? ---8--- (months)
اضافي کاڏو مهينا

C. Immunization (the oldest child under 5 years) حفاظتي ٽڪا (پنجن سالن کان گهٽ)

C1. Did the child receive any immunization?
بار ڪي ٽڪا لڳل آهن ؟

1 [✓] Yes ها 2 [ ] No نه

9 [ ] Don't know خبر نه آهي

IF NO OR DON'T KNOW GO TO QUESTION C3. IF YES
جيڪڏهن جواب نه ۾ يا "خبر نه آهي" هجي تو ته سوال C3 ڏانهن وڃو
جيڪڏهن "ها" ته

C2. Complete the following table? هيٺ ڏنل خانا ڀريو

	B.C.G.* بي سي جي	Polio * پوليو	D.P.T. * دي پي ٽي	Measles * ارڙو
First Dose پهريون دوز	1			2
2nd Dose ٻيو دوز	@@@@@@@@@@@			@@@@@@@@@@
3rd Dose ٽيون دوز	@@@@@@@@@@@			@@@@@@@@@@

[* CODE 1 = Yes, 2 = No, 9 = Don't know]
ڪوڊ ها نه خبر نه آهي

C3. Why was the child not immunized?
ٻار کي ڪهڙي ڪاڄي سهري نه ڪيرايا ؟

1 [ ] Facility not available
سهولت ميسر نه آهي

2 [ ] Facility too far
مرڪز تمام پري آهي

3 [ ] Do not believe in immunization
ٽيڪن ماڻهو فائدو نه آهي

4 [ ] Other (specify) ----------
ٻيو سبب

D. Present Diseases (under 5 years)
پنجن سالن کان گهٽ ٻارن ۾ موجود بيمارين

D1. Has the child had more than 3 loose stools in a day in the past 14 days?
گذريل چن ڏينهن دوران ٻار کي اڌ دست ڏيڻ جيڪي رات ڏينهن ۾ ٽي دفعن کان وڌيڪ ٿيا آهن

1 [ ] Yes ها
2 [✓] No (go to D4) نه (هاڪ ڏانهن وڃو)

D2. How long?
عرصو
1. [✓] Less than 7 days 7 ڏينهن کان گهٽ
2. [ ] More than 7 7 ڏينهن کان وڌيڪ

D3. What did you do in case of diarrhea?
هن حالت دوران توهان ڇا ڪيو ؟

1 [ ] Plain water
سادو پاڻي
2 [✓] None
ڪجهه به نه

3 [ ] ORS
نمڪول
4 [ ] Other (specify) ----------
ٻيو ڪجهه

D4. Have you ever used ORS for loose stools of your children?
ڇا توهان ڪڏهن ٻار کي نمڪول ڏيڻ جو سوچيو آهي ؟

1 [ ] Yes ها
2 [✓] No نه

D7. Has the child had pus comingout from ears in the past 14 days? چاڳ لڏريل ڏهن ڏينهن دوران ٻار جو ڪنن ڏاهنڊ رڌيو آهي؟

1 [ ] Yes ها
2 [✓] No نه
3 [ ] Don't know خبر نه آهي

D8. Does any of the child (>2 years) unable to see in darkness (Shabkhoor)? ٻن سالن کان وڏي ٻارن ۾ ڪنهن کي هڪڙهن اونداهه ۾ ڏسڻ ۾ تڪليف رهي آهي؟

1 [ ] Yes ها
2 [✓] No نه
3 [ ] Don't know. خبر نه آهي

D9. Has the child passed/vomited worms during the past 3 months? گذريل ٽن مهينن دوران هڙهن ٻار جي پيٽ يا الٽي ۾ جيئان = ننڍڙن ڪيڙن آهن؟

1 [ ] Yes ها
2 [✓] No نه
3 [ ] Don't know خبر نه آهي

Name:

Anthropometry (Male=1 Female=2)		
The [ ] child in the household Age 1½-6M Sex M		
E1. Height/Length جِ نگھہ (5)	E1A. 1 [√] Child board 2 [ ] child scale	E1B. 75.2 cm _____ Inchs
E2. Weight وزن (3)	E2A. 1 [√] Salter 2 [ ] Child scale	E2B. 9.12 kg
E3. Midarm بانھن جي وچ ڀڳين جي ماپ Circumference		15.1 cm

Name: Anthropometry (Male=1 Female=2)		
The [ ] child in the household Age _____ Sex _____		
E1. Height/Length جِ نگھہ	E1A. 1 [ ] Child board 2 [ ] child scale	E1B. _____/_____ cm _____ inchs
E2. Weight وزن	E2A. 1 [ ] Salter 2 [ ] Child scale	E2B. _____/_____ kg
E3. Midarm بانھن جي وچ ڀڳين جي ماپ Circumference		_____/_____ cm

Note: Write child's ID number in brakets [ ] from page 4 and 5.

Appendix D: 1997 Family Health Project (FHP) Survey

FAMILY HEALTH PROJECT

DEMOGRAPHIC AND HEALTH SURVEY, SINDH PAKISTAN

Study Number:[ ]

IDENTIFICATION (A)
NAME OF HOUSEHOLD HEAD _____
ADDRESS _____
_____
NAME OF RESPONDENT _____
URBAN/RURAL (urban=1, rural=2) _____
DIVISION/DISTRICT _____
CLUSTER NUMBER _____
HOUSEHOLD NUMBER _____

INTERVIEWER VISITS (B)	
DATE	_____
INTERVIEWER'S NAME	_____
RESULT (to be filled by editer)	_____
NEXT VISIT: DATE	_____
TIME	_____
EDITED BY	DATA ENTRY
NAME _____	DATA ENTRY 1 _____
DATE _____	DATA ENTRY 2 _____
SIGNATURE _____	

HOUSEHOLD SCHEDULE (C)

Now I would like some information about the people who usually live in your household. (from last six month s)

S#	Residents	Relationship to head House hold*	Sex	Age			Marital status	Education
(a)	Please give the names of the person who usually live in your household or are staying with you now, starting with the head of the House hold. (b)	What is the relationship of (NAME) to the head of the House hold (c)	Is (NAME) male or female (d)	How old is (NAME) in day/month/year (e)			(For all aged 12 and above) What is (Name) marital status (f)	What is the education level of (NAME)***? (g)
F.S #	@@@@@@@@@@@@ @@@@@@@@@@@@	@@@@@@@@@ @@@@@@@@@	M F 1 2	D	M	Y	@@@@@@	Level
1			1 2					
2			1 2					
3			1 2					
4			1 2					
5			1 2					
6			1 2					
7			1 2					
8			1 2					
9			1 2					
10			1 2					
11			1 2					

* Codes for Relationship to Head of Household (b)

1= Head
2= Wife or husband
3= Son or daughter
4= Son or daughter-in-law
5= Grand child
6= Parent
7= Parent-in-law
8= Brother or sister
9= Other relative
Specify _____
10= Not related
99= Dont know

** Codes for marital status(e)

1= Never married
2= Married
3= Widowed
4= Divorced
5= Separated
99= Dont know

*** Codesfor Education (f)

1= Illiterate
2= Can read news paper
3= Can read & write
4= Upto class V
5= Upto class X
6= Upto Inter
7= Graduated or above
8= Can read Quran only
99= Dont know

HOUSEHOLD SCHEDULE (C) (contd.)

F.S. #	Residents	Relationship to head House hold*	Sex	Age			Marital status	Education
	Please give the names of the person who usually live in your household or are staying with you now, starting with the head of the House hold.	What is the relationship of (NAME) to the head of the House hold	Is (NAME) male or female	How old is (NAME) in day/month/year			(For all aged 12 and above) What is (Name) marital status	What is the education level of (NAME)***?
(a)	(b)	(c)	(d)	(e)			(f)	(g)
@@	@@@@@@@@@@@@	@@@@@@@@	M F 1 2	D	M	Y	@@@@@@	Level
13			1 2					
14			1 2					
15			1 2					
16			1 2					
17			1 2					
18			1 2					
19			1 2					
20			1 2					
21			1 2					
22			1 2					
23			1 2					

* Codes for (b)

** Codes for marital status(e)

*** Codesfor Education (f)

Relationship to Head of Household (H. Hold) (b)

1= Head
2= Wife or husband
3= Son or daughter
4= Son or daughter-in-law
5= Grand child
6= Parent
7= Parent-in-law
8= Brother or sister
9= Other relative
10= Not related
99= Dont know

1= Never married
2= Currently married
3= Widowed
4= Divorced
5= Separated
99= Dont know

1= Illiterate
2= Can read news paper
3= Can read & write
4= Upto class V
5= Upto class X
6= Upto Inter
7= Graduated
8= Can read Uuran only
99= Dont know.

If more than 23 persons please attach another sheet

Tick here if continuation sheet used _____

h Total number of people in the house hold _____

I Total # of females _____ **J** Total # of males_____

WATER AND SANITATION (D)

D1	What is the source of drinking water for members of your H. Hold?	Piped into residence Piped into boundary 1 Public tap 2 Hand pump/tube well 3 Well 4 River, spring & surface water 5 Tankers 6 vendor 7 Other (specify) _____ 8
D2	What kind of toilet facility does your House Hold have?	Flush Bucket 1 Pit 2 Open space attached with house 3 No facility 4 Other (specify)_____ 5
D3	Does your House Hold have: Electricity? A radio/tape recorder? A television? A refrigerator? A room cooler? A washing machine? A water pump? An air conditioner ?	Yes No Not Specified Yes No Not specified 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3
D4	Does any member of your House Hold own: A bicycle? A motor cycle? A car, van or tractor? An Animal cart	Yes No Not specified 1 2 3 1 2 3 1 2 3 1 2 3
D5	Do you own any cattle? (for rural areas only)	Yes..... 1 Category Quantity

	If No skip , D6	1. Buffalo _____ 1 2. Cow// Ox _____ 2 3. Goat _____ 3 Others(specify) _____ No .... 2 Skip to D7
D6	Where do you keep your cattle?	Inside the house 1 Nearby the house 2 Away from the house 3 Others Specify----------
D7	What is the type of your house? (Interviewer observation)	Pucca 1 Semi Pucca 2 Katcha 3 Bush 4 Other specify_____
D8	How many rooms in your House Hold are used for sleeping?	Rooms.....
D9	What is the location of your kitchen?	Inside the living rooms..... 1 Separate from the living room.....2 Others Specify----------
D10	Where do you keep your cattle?	Inside the house Nearby the house Away from the house 1 Does not own cattle 2 Others Specify---------- 3 4

PREGNANCY AND ANTENATAL CARE (E)
FOR MARRIED WOMAN WITH ATLEAST ONE CHILD I

Now I would like to talk to you about the care you got during your pregnan

E1. How many times did you became pregnant in last three years ?_____
Please specify

Total number of abortion ☐

Total number of live birth ☐

Total number of still birth ☐

Self	1	1 Self 1
Member of H. H	2	2 Member of H. H 2
LHV/Nurse/Doctor	3	3 LHV/Nurse/Doctor 3
LHW	4	4 LHW 4
TBA.	5	5 TBA. 5
No one	6	6 No one 6
Other _____ (specify)		Other _____ (specify)

E2. Are you pregnant now? _____ (Yes 1, No 2, Dont know 9)
If No, Skip E ,14, 15, 16, 17, 18,19 .

Give details of each pregnancy in last three years

		Last Birth (youngest) Name _____ Alive.....01 Dead 02	Next-to-Last Birth Name _____ Alive.....01 Dead.....02	Second-From - Last Birth Name _____ Alive .....01 Dead.....02
E3	When you were pregnant with (NAME), Did you see any one for ante natal care for this pregnancy?	Doctor 1 Nurse 2 LHV. 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)	Doctor 1 Nurse 2 LHV. 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)	Doctor 1 Nurse 2 LHV. 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)
E4	If yes who advised you for this ante natal check ups.			

		Self 1 Member of H. H 2 LHV/Nurse/Doctor 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)		
E5	Were you given an ante natal card for this pregnancy?	Yes.....1 No.....2 Dont know...99	Yes.....1 No.....2 Dont know..99	Yes.....1 No.....2 Dont know..99
E6	How many months pregnant were you when you first saw someone for an ante natal check up for that pregnancy?	Months.... Dont know..99 ☐	Months... Dont Know.99 ☐	Months... Dont know.99 ☐
E7	How many ante natal visits did you have during that pregnancy?	Number of visits. Dont know...99 ☐	Number of visits. Dont know.99 ☐	Number of visits.. Dont know.....99 ☐
E8	Did anyone advise you to eat more food than usual during that pregnancy?	Yes.....1 No.....2 Don't Know 99		
E9	Were you weighed at any time during that pregnancy?	Yes.....1 No.....2 Don't Know 99		
E10	When you were pregnant with (Name) were you given an injection in the arm to prevent the baby	Yes.....1 No.....2	Yes.....1 No.....2	Yes.....1 No.....2

	from getting tetanus, that is, convulsions after birth?	Dont know...99	Dont know..99	Dont know..99
E11	If yes, how many times did you get this injection?	Times.... Dont know...99	Times..... Dont know..99	Times..... .Dont know....99
E12	Where did you give birth to (Name)?	Your Home 1 Other Home 2 Govt. Hosp.RHC/ BHU/Govt. Clinic (probe) 3 P. Hospital/ Clinic 4 Other_____ (Specify)	Your Home 1 Other Home 2 Govt. Hosp. RHC/BHU/ Govt. Clinic (probe) 3 P. Hospital/ Clinic 4 Other_____ (Specify)	Your Home 1 Other Home 2 Govt. Hosp. RHC/BHU/ Govt. Clinic (probe) 3 P. Hospital/ Clinic 4 Other_____ (Specify)
E13	Who delivered (Name) or assisted with the delivery?	Self 1 Member of H. H 2 LHV/Nurse/Doctor 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)	Self 1 Member of H. H 2 LHV/Nurse/Doctor 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)	Self 1 Member of H. H 2 LHV/Nurse/Doctor 3 LHW 4 TBA. 5 No one 6 Other _____ (specify)

Skip to Section (F) if the mother is not presently pregnant.

Now I would like to ask some questions about the present pregnancy.

E 14. Months of current pregnancy _____(Write number of months).

E 15. For this pregnancy did you see any one for antenatal care?

Codes : Yes ----------1
No ---------- 2 Skip to section F
Not specified---3

E 16. Who is providing the antenatal care?

Codes: Doctor
Nurse
LHV
LHW 1
TBA 2
Other (speci 3 _____
4
5

E 17. Were you gi... ...nte natal card for this checkup?

Codes: Yes---------- 1
No---------- 2
Dont know ---------99

E 18. How many months were you pregnant when you first see any one for this antenatal check ups?

Months

Dont know---------- 99

E 19. Were you given TT injection during this pregnancy?

Codes: Yes---------- 1
No---------- 2
Dont know ---------99

BREAST FEEDING AND WEANING (F)
FOR THE ELDEST CHILD LESS THAN TWO YEARS

Now I would like to ask some question regarding the health of your eldest child less then two years. (If you have twin s, we will talk about the eldest).

Name of the eldest child under 2 years----------
Age : D M Y

Face Sheet # _____

(Check with F.S. # in section C)

Sex Male----------1
Female-------2 ☐☐☐

F1	How long after birth did you first put (Name) to the breast? If less than 1 hour, record `00' hours, if less than24 hours, record hours. Otherwise record days	Immediately..... 00 Hours.....1 Days.....2 Breast feed not given.....96
F2	What was (Name) fed before you put (him/her) to the breast?	Water.....1 Gutti.....2 Honey.....3 Sugar.....4 Nothing.....5 Other_____ (Specify)
F3	How many months old was (Name) when you started giving the following on a regular basis? Formula or milk other than breast milk? Water? Other liquids? Any solid or soft food? If less than 1 month, record `00'	 Age in months..... Not given.....96 Age in months..... ☐ Not given.....96 ☐ Age in months..... Not given.....96 Age in months..... ☐ Not given.....96 ☐
F4	How many months did you breast feed?	Months..... ☐☐ Still feeding.....2 Breast feed not given.....96 Don't know.....99
F5	Were (Name) ever given: **a**. Nipple **b**. Bottle with nipple	**a** **b** Yes 1 1 No 2 2 Dont know 99 99

MORBIBITY DIARREAOH (G)

FOR CHILDREN LESS THAN THREE YEARS

Age	**_____/Days** **_____/Months** **_____/ Years**	**_____/Days** **_____/Months** **_____/Years**	**_____/Days** **_____/Months** **_____/Years**
Sex	**Male ---1 Female----2**	**Male ---1 Female----2**	**Male ---1 Female----2**
G1	During the last 14 days, did the child (Name) had more than 3 loose stools in a day (24 hours).	Yes.1 No....2 ➔ Dont know....99.	Yes..1 No....2 ➔ Dont know....99.	Yes..1 No....2 ➔ Dont know....99.
G2	Was there fresh blood in stools?	Yes.....1 No.....2 Dont know....99	Yes.....1 No.....2 Dont know....99	Yes.....1 No.....2 Dont know..99
G3	How many days the diarrhea continued?	Days..... ☐ Don't know.....99	Days..... ☐ Don't know.....99.	Days..... ☐ Don't know.....99
G4	What did you give for the last episode of diarrhea?	Nothing.....1 Medication.....2 ORS.....3 Other (Specify).....		
G5	Did you give ORS for the last episode of diarrhea?.	yes.....1 No.....2 Dont know.....99	yes.....1 No.....2 Dont know.....99	yes.....1 No.....2 Dont know.....99
G6	If No why not?	ORS not available.....1	ORS not available.....1	ORS not available.....1

		went to seek advise.....2 give medicine.....3 Other (Specify).....4 Dont know.....99	went to seek advise.....2 give medicine.....3 Other (Specify).....4 Dont know.....99	went to seek advise.....2 give medicine.....3 Other (Specify).....4 Dont know.....99
G7	From whom did you seek advice or treatment? (Circle all mentioned)	Govt. Hospital 1 BHU/RHC/Gvt Cl 2 Pvt Hosp/Clinic 3 Pvt. Doctor 4 FWW 5 LHV 6 LHW 7 Homeopath 8 Hakim 9 Faith healer 10 Drug store 11 Shop (other than drug store) 12 Other_____ (Specify)	Govt. Hospital 1 BHU/RHC/Gvt Cl 2 Pvt Hosp/Clinic 3 Pvt. Doctor 4 FWW 5 LHV 6 LHW 7 Homeopath 8 Hakim 9 Faith healer 10 Drug store 11 Shop (other than drug store) 12 Other_____ (Specify)	Govt. Hospital 1 BHU/RHC/Gvt Cl 2 Pvt Hosp/Clinic 3 Pvt. Doctor 4 FWW 5 LHV 6 LHW 7 Homeopath 8 Hakim 9 Faith healer 10 Drug store 11 Shop (other than drug store) 12 Other_____ (Specify)

IMMUNIZATION STATUS (H)

Ha. Now I would like to ask you about the immunization of children under three years of age.

Codes :Yes on card .....1, Not given 3
Yes with out card.....2 Dont remember....99

F.S #	Name	Age Dys	Mns	Yrs	Sex M F	BCG	Polio				DPT			DP T	Measles
@@ @@	@@@@@ @@@@@	@@ @@	@ @	@@ @@	1 2	at Birth	at Birth	1	2	3	1	2	3		
					1 2										
					1 2										
					1 2										
					1 2										
					1 2										
					1 2										

Hb Now I would like to ask you about the immunization of the females of child bearing age.

Total number of CBAs in this house hold? ☐☐

Codes :Yes on card -----1, Yes with out card------2, Not given -------3, Dont remember---------99

S#	Name	TT1	TT2	TT3	TT4	TT5

DEATHS DURING THE LAST FIVE YEARS (I)

I1. Was there any death in this Household during last five years?

Yes.....1
No.....2 Skip to section J

I2 If yes, how many deaths took place in this household during last 5 years?
(include the children who were born alive & died during last 5 years, include both boys & girls)

S#	Name relation with the head of household 1. Spouse 2. Son / daughter 3. Son/daughter-in-law 4. Grand children 5. Parent/G parent 6. Brother/sister 7. Parent in law 8. Brother/sister-in-laws Other		Sex Male Female		Age at Death		
	Name	Relation	M	F	in days	in months	in years
			1	2			
			1	2			
			1	2			
			1	2			
			1	2			
			1	2			
			1	2			
			1	2			
			1	2			
			1	2			

Interviewer please confirm deaths for consistency check from the respondent and fill following questions.

1. Total deaths (all ages & both sexes) in LAST FIVE YEARS

2. Total infant deaths (<1year) in LAST FIVE YEARS

3. Total child deaths (1 to <5years) in LAST FIVE YEARS

4. Total female death during pregnancy or within 42 days of delivery in this household DURING LAST 5 YEARS?

CONTRACEPTION (J)

J1	Now I would like to talk about family planning - the various ways or methods that a couple can use to delay or avoid pregnancy. Which ways or methods have you heard about?			
		J 2	J3	J4
		Have you ever heard of (Method)? Read description of each method	Have you ever used (Method)?	Do you know where a person could go to get
01	Pill-Women can take a pill every day	Yes/spont.....1 Yes/probed....2 No.....3	Yes.....1 No.....2	Yes.....1 No.....2
02	IUD-Women can have a loop or coil placed inside them by a doctor or a nurse	Yes/spont.....1 Yes/probed....2 No.....3	Yes.....1 No.....2	Yes.....1 No.....2
03	Injections-Women can have an injection by a doctor or nurse which stops them from becoming pregnant for several months	Yes/spont.....1 Yes/probed....2 No.....3	Yes.....1 No.....2	Yes.....1 No.....2
04	Diaphragm, foam, jelly women can place a sponge, suppository, diaphragm, jelly or cream inside them before intercourse	Yes/spont.....1 Yes/probed.....2 No.....3	Yes.....1 No.....2	Yes.....1 No.....2
05	Condom-Men can use a rubber sheath during sexual inter course	Yes/spont.....1 Yes/probed.....2 No.....3	Yes.....1 No.....2	Yes.....1 No.....2

	(Contd.)			
		Have you ever heard of (Method)? (Method) Read description of each method	Have you ever used (Method)? (Method)	Do you know where a person could go to get (Method)
06	Female sterilization-Women can have an opertion to avoid having any more children	Yes/spont.....1 Yes/probed...2 No.....3	Have you ever had an operation to aovid having any more children? Yes.....1 No.....2	Yes.....1 No.....2
07	Withdrawl - Men can be careful and pull out before climax	Yes/spont.....1 Yes/probed....2 No.....3	Yes.....1 No.....2	
08	Have you heard of any other ways or methods that women or men can use to avoid pregnancy?	1. _____ (Specify) 2. _____ (Specify) 3. _____ (Specify		

J5	Are you currecntly doing something or using any method to delay or avoid getting pregnant? If Yes dont ask J7	Yes.....1 No.....2 -----> J7 Presently pregnant....3-----> J8
J6	Which method are you using? (multiple responses possible)	Pill 1 IUD 2 Injections 3 Diaphragm/Foam/Jelly 4 Condom 5 Female sterilization 6 Male sterilization 7 Periodic Abstinence 8 Withdrawl 9 Other_____ (Specify)
J7	What is the main reason you are not using a method to delay or avoid getting pregnant? (multiple responses possible)	Wants (more) children. 1 Lack of knowledge 2 Husband opposed 3 Cost too much. 4 Worry about side effects 5 Health concerns 6 Hard to get method 7 Religion 8 Opposed to FP 9 Fatalistic 10 Other people opposed 11 Infrequent sex 12 Difficult to get pregnant 13 Hysterectomy 14 Inconvenient 15 Husband absent 16 Breast feeding. 17 Dont know.. 99 Other_____ (Specify)
J8	Do you intend to use a method to delay or avoid pregnancy at any time in future?	Yes.....1 No.....2 Dont know.....99

UTILIZATION OF HEALTH CARE SERVICES(K)

K1	Where do you usually go to seek health care?	Govt. Disp. (BHU) .....1 Private clinic .....2 Govt. Hosp. (RHC) .....3. Any Other (Specify)_____
K2	Where did you seek medical advice for last illness in your house hold?	Govt. Disp. (BHU) .....1 Private clinic .....2 Govt. Hosp. (RHC) .....3. Any Other (Specify)_____
K3	Who advised you to go?	My self .....1 Member of H.H.....2 Friend..... .....3 LHW.....4 TBA.....5 Any other specify_____
K4	What is the name of the near by government health facility?	Specify_____ Don't know 99
K5	Did Lady Health Worker of your area visit your house ?	Yes.....1 No.....2 Don't know.....99
K6	What is the name of your Lady Health Worker?	Write name _____ Don't Know.....99
K7	When did the Lady heath worker visit your house last ?	Last month.....1 2-3 month.....2 4-6months.....3 Last year .....4 Never.....5 Dont remember.....6 Don't know 99
K8	Which of the activities the LHW did when she last visited your house hold	Collected information about H. H. .....1 Filled the register.....2 Weighed the child.....3 Gave advice on FP, weaning etc.....4 Gave ORS packets.....5 (If child had diarrhoea at the time of visit) Did antenatal care .....6 (If mother was pregnant at the time of visit)

HOUSEHOLD SCHEDULE (C) (Additional Sheet)

S#	Residents	Relationship to head House hold*	Sex	Age			Marital status	Education
	Please give the names of the person who usually live in your household or are staying with you now, starting with the head of the House hold.	What is the relationship of (NAME) to the head of the House hold	Is (NAME) male or female	How old is (NAME) in day/month/year			(For all aged 12 and above) What is (Name) marital status	What is the education level of (NAME)***?
(a)	(b)	(c)	(d)	(e)			(f)	(g)
			M F 1 2	D	M	Y		Level
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					
			1 2					

* Codes for (b) ** Codes for marital status(e) *** Codesfor Education (f)

Relationship to Head of Household (H. Hold) (b)

1= Head
2= Wife or husband
3= Son or daughter
4= Son or daughter-in-law
5= Grand child
6= Parent
7= Parent-in-law
8= Brother or sister
9= Other relative
10= Not related
99= Dont know

1= Never married
2= Currently married
3= Widowed
4= Divorced
5= Separated
99= Dont know

1= Illiterate
2= Can read news paper
3= Can read & write
4= Upto class V
5= Upto class X
6= Upto Inter
7= Graduated
8= Can read Uuran only
99= Dont know.

If more than 24 persons please attach another sheet

Tick here if continuation sheet used _____

8 Total number of people in the house hold _____

9 Total # of females _____ (10) Total # of males_____

Appendix E: University of Saskatchewan Ethics Letter

UNIVERSITY OF SASKATCHEWAN

Ethics Office

Dr. Valerie Thompson, Chair
Behavioural Research Ethics Board
University of Saskatchewan
Room 306 Kirk Hall, 117 Science Place
SASKATOON SK S7N 5C8 CANADA
Phone: 966-2084 Fax: 966-2069
Email: Valerie.thompson@usask.ca

MEMORANDUM

To: Dr. Syed Shah – Community Health and Epidemiology
Maureen Horn – Community Health and Epidemiology

Date: April 26, 2006

Re: Childhood Immunization in Rural Pakistan, 1994 and 1997

The study entitled, "Childhood Immunization in Rural Pakistan, 1994 and 1997" is exempt from the Research Ethics review process. This decision is based on the information provided in your ethics application on April 11, 2006.

Article 3.3 of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (1998) specifies that REB review and approval is not required to conduct a secondary analysis of data that cannot be linked to individuals, and for which there is no possibility that individuals can be identified in any published reports.

It should be noted that though your project is exempt of ethics review, your project should be conducted in an ethical manner (i.e. in accordance with the information that you submitted). It should also be noted that any deviation from the original methodology and/or research question should be brought to the attention of the Behavioural Research Ethics Board for further review.

Sincerely,

Dr. Valerie Thompson, Chair
Behavioural Research Ethics Board
University of Saskatchewan

Appendix F: List of Variables Available in the 1997 FHP Dataset

I = independent variables used in analysis
D = dependent variables used in analysis
N/A = variables used for organization of data or for deriving variables

N/A	fmain_ke	Main Household ID#
I	childage	Age of Child in Months
I	childsex	Sex of Child
		0 = male
		1 = female
N/A	Totfmem	Total # Household Members
N/A	Rooms	# Rooms Used for Sleeping
I	Death5	Any Household Deaths (past 5 years)
		1 = yes
		2 = no
		3 = don't know
I	NEWelectricity*	Household electricity
		1= yes
		2 = no
I	Radio*	Own Radio/Tape Recorder
		0 = yes
		1 = no
I	Tv*	Own a TV
		0 = yes

		1 = no
I	Refreg*	Own a Refrigerator
		0 = yes
		1 = no
I	Wmachine*	Own a Washing Machine
		0 = yes
		1 = no
I	Wpump*	Own a Water Pump
		1 = yes
		2 = no
I	Acondi*	Own an Air Conditioner
		0 = yes
		1 = no
I	Mbike*	Own a Motorcycle
		0 = yes
		1 = no
I	Car*	Own a Car/Van
		0 = yes
		1 = no
I	NEWbicycle*	Own a Bicycle
		1 = yes
		2 = no
I	NEWhoustpe*	House Type

		1 = pucca
		2 = kucha
I	Visitchw*	Does a LHW visit your house
		0 = yes
		1 = no
N/A	NEWbcg*	Has Child Received BCG
		1 = yes
		2 = no
N/A	NEWpolio1*	Has Child Received Polio #1
		1 = yes
		2 = no
N/A	NEWpolio2*	Has Child Received Polio #2
		1 = yes
		2 = no
N/A	NEWpolio3*	Has Child Received Polio #3
		1 = yes
		2 = no
N/A	NEWdpt1*	Has Child Received DPT #1
		1 = yes
		2 = no
N/A	NEWdpt2*	Has Child Received DPT #2
		1 = yes
		2 = no

N/A	NEWdpt3*	Has Child Received DPT #3
		1 = yes
		2 = no
N/A	NEWmeasle*	Has Child Received MCV
		1 = yes
		2 = no
D	NEWimmstatus3**	Complete Immunization Status (12-36 mo.)
		0 = Incomplete
		1 = Complete
D	NEWimmstatus4**	Age Appropriate Immunization (birth-9 mo.)
		0 = Not Age Appropriate
		1 = Age Appropriate
I	NEWovercrowding**	Overcrowding (>3 people/room)
		0 = no
		1 = yes
I	NEWdivdist*	Division District of Residence
		1 = Thatta
		2 = Tharparkar
		3 = Badin
		4 = Mirpur Khas
I	HearCcontraception**	Ever heard of at least one kind of contraception
		1 = yes

		2 = no
I	UseContraception**	Ever used/using at least one kind of contraception 1 = yes 2 = no
I	Seekheal_recoded*	Where do you usually seek health care 1 = Government Facility (e.g. hospital) 2 = Private Clinic

*** recoded into binary form**

**** derived variables**

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